ENGINE 21B

Index **Page**

General Description 2

Service Adjustments and Checks 7

Special Service Tool Recognition 8

Service and Repair Operations – Content 11

Service and Repair Operations 12

Technical Data 72

GENERAL DESCRIPTION

Transit range vehicles may have both diesel engines and various petrol engine types fitted. Petrol engines are in-line as well as V4 and V6 versions.

This section covers the Ford diesel engine **only**. For easier identification this engine is designated with the code letter 'G' in line with other workshop manuals. The table below lists the engine types built in Germany and the United Kingdom respectively.

ENGINE SUMMARY

Cubic Capacity Litres	Compression Ratio	Type	HP (kw)	Engine Code		Source	
				Vehicle plate	Workshop Manual	Germany	U.K.
2,4	DIESEL	OHV/I-4	62 (46)	4A	G	X	X
1,5	LC	OHV/V4	60 (44)	EX	D	X	—
1,6	LC	OHV/I-4	65 (48)	L1	A	—	X
1,7	LC	OHV/V4	65 (48)	MX	D	X	—
2,0	LC	OHV/V4	70 (51)	NX	E	X	X
2,0	HC	OHV/V4	80 (59)	NY	E	—	X
3,0	LC	OHV/V6	100 (74)	HX	F	—	X

OHV = overhead valves

I-4 = in-line 4 cylinder engine

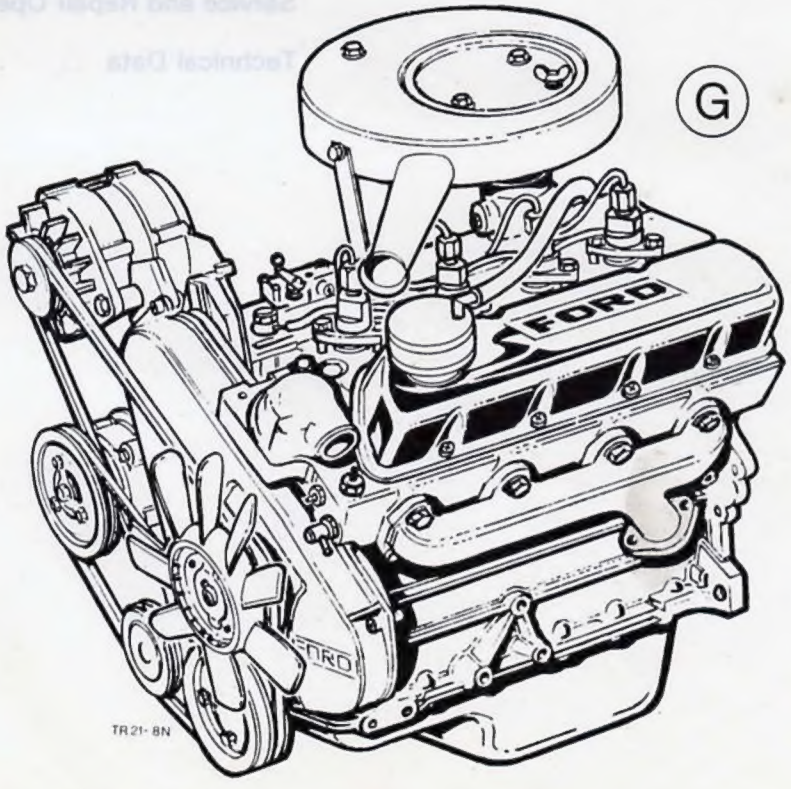


Fig. 1. 'G' Engine

GENERAL DESCRIPTION (cont'd)

The 'G' engine is a water-cooled 4 cylinder 4 stroke in-line indirect injection diesel engine (Fig. 1).

The combined fuel injection and fuel lift pump, fuel filter, brake pump and full-flow oil filter are all located on the right-hand side of the engine. The rotor oil pump is located at the front and is driven by a crankshaft gear. The fuel injection pump is driven via a toothed belt which also drives the camshaft. Similarly, alternator, brake pump and water pump are driven by the crankshaft via a V-belt.

In order to achieve low overall height (compact layout) the cylinders are mounted at an angle of 22,5 degrees to the left of vertical. To give maximum crankshaft drive stability the crankshaft is carried on five main bearings. Centre main bearing end float is determined by four half thrust washers.

The floating piston pins are located in the connecting rods (with bushes) and secured with two circlips. Pistons have two compression rings and one oil scraper ring. The camshaft which is carried on five bearings is located in the cylinder block on one side of the engine and driven by the crankshaft via a toothed belt which, as already mentioned, also drives the fuel injection pump. A drilling through the shaft carries oil to the replaceable bearings.

Overhead valve timing is effected via tappets, push rods and rocker arms. The rocker shaft has a drilling for rocker arm lubrication. Valves are arranged in the cylinder head in alternating sequence, commencing with an exhaust valve at the front of the engine. Inlet valves have one progressive coil spring and exhaust valves two. Valve adjusting screws are self-locking. Inlet and exhaust valves have different seat angles. Cylinder head valve guides are exchangeable.

The thermostart control incorporated in the inlet manifold ensures quick starting of the engine in low temperature conditions.

An automatic shut-off control fitted to the engine compartment splash shield enables the injection pump to be set to zero lift via a cable, thereby stopping the engine.

The fuel injection pump timing mark is located on the advance unit on top of the pump.

The engine has combustion chambers divided into a turbulence chamber located in the cylinder head and the main combustion chamber in the cylinder itself.

GENERAL DESCRIPTION (cont'd)

Lubrication Circuit, Fig. 2

The rotor oil pump located at the front of the engine block is driven by a gear on the crankshaft and draws oil via a strainer and suction pipe (lower drilling) from the oil sump.

The filtered oil is fed through the upper drilling via the pump relief valve into the full-flow oil filter and from there through the central axis of the oil filter cartridge to the main oil gallery. A by-pass valve located on the filter central axis opens in order to enable oil to pass directly into the main gallery in the event of oil filter cartridge blockage (by sludge, etc.).

The pump relief valve in the cylinder block, between the oil pump and the full-flow oil filter, is connected to the main oil gallery. Excessive oil pressure will force a small spring-loaded plunger downwards, with the downward movement of the plunger freeing the valve plunger drillings in the direction of the lower gallery thereby providing a direct connection between oil suction tube and pressure duct.

The five main bearings are connected to the main oil gallery. The big end journals are supplied with oil via diagonal lubrication passages from the nearest main crankshaft bearing.

The first four main bearing supports in the cylinder block have splash oil drillings which ensure splash lubrication of piston pins and better cooling of piston tops.

From the centre main bearing the oil passes via the centre camshaft bearing to the camshaft and from there through drillings to the remaining camshaft bearings.

Oil flows from the centre camshaft bearing through a cylinder block drilling to the cylinder head into the rocker arm shaft and to the rocker arms. Valve stems are lubricated by means of oil discharged through the rocker arm drilling.

Both the fuel injection pump and the lift pump are permanently lubricated with oil from the main oil gallery fed to the pumps via engine block and timing cover drillings. The return oil flow to the pump passes through the timing cover. The oil pressure switch which is screwed into the gallery on the right-hand side of the engine block is in direct communication with the main oil gallery.

GENERAL DESCRIPTION (cont'd)

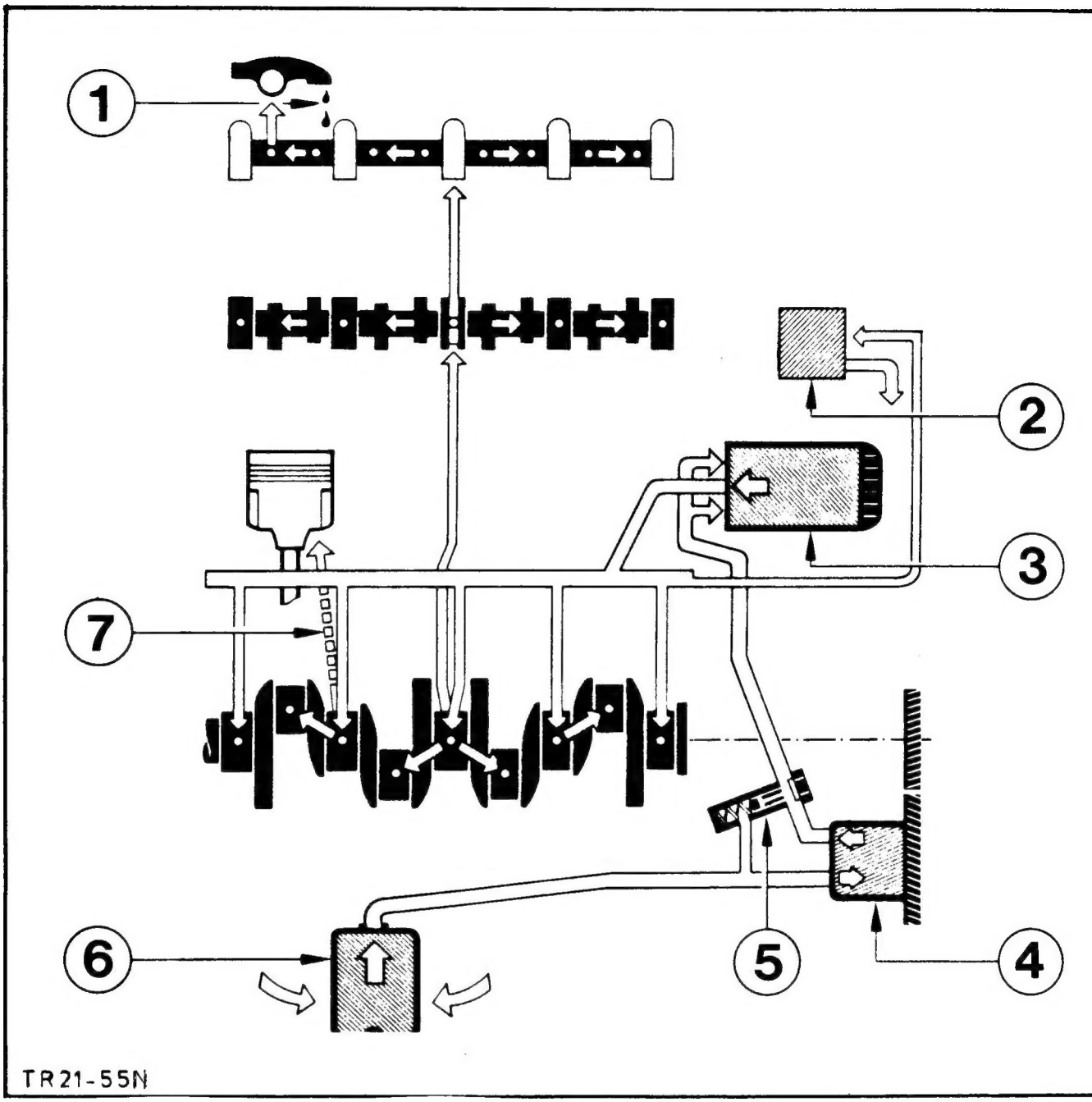


Fig. 2. Lubrication circuit
1. Valve stem drip feed lubrication system
2. Fuel injection pump
3. Exhauster pump
4. Full-flow oil filter
5. Rotor oil pump
6. Oil pump relief valve
7. Oil suction strainer
8. Piston splash lubrication system

GENERAL DESCRIPTION (cont'd)

Engine Ventilation System, Fig. 3

The mixture of air and crankcase fumes passes through the cylinder head into the rocker cover from where it is drawn through the oil separator and oil filler connecting hose into the inlet manifold and the filtered air, together with the air drawn through the air cleaner, is fed into the cylinder combustion chambers.

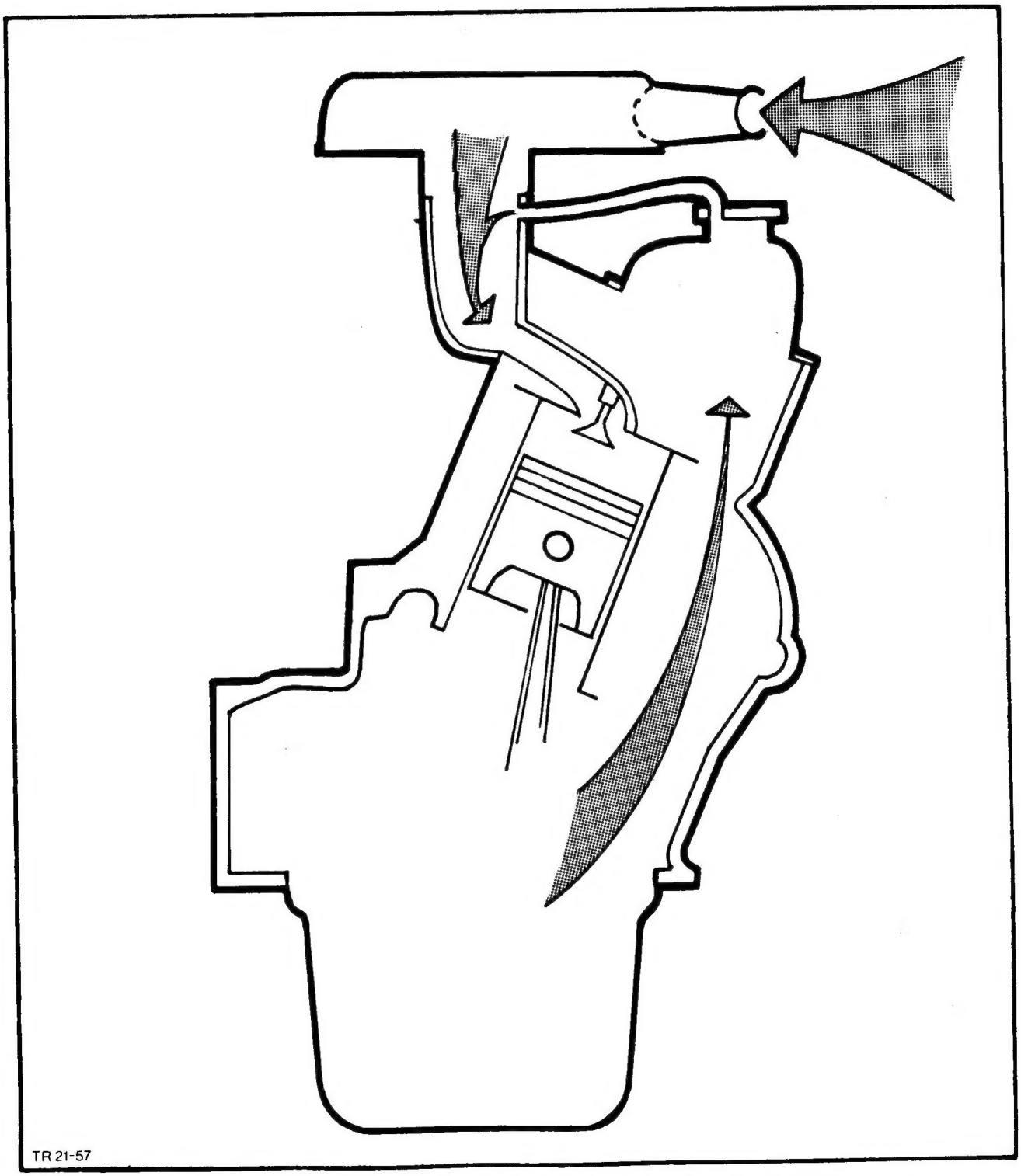


Fig. 3. Engine ventilation

GENERAL DESCRIPTION (cont'd)

Engine Identification and Engine Serial Numbers

Regulations in force in certain countries provide for engines to be marked with identification codes and serial numbers. Fig. 4 and 5 show where these data are marked on the engine. Minimum height of letters and numbers is 6 mm (0,25 in) and both codes and serial numbers (e.g. on replacement engines) should be marked in such a manner that they can be clearly recognised by the appropriate testing authorities, thereby preventing rejection of engines.

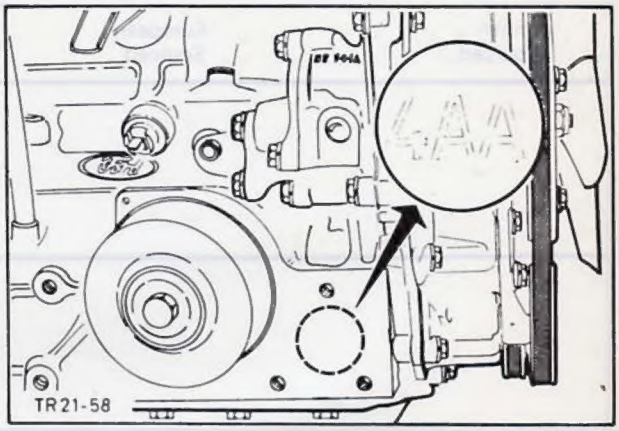


Fig. 4. Engine identification code

SERVICE ADJUSTMENT AND CHECKS

To check the engine oil level the vehicle should stand on level ground and the engine should be at normal operating temperature. Before carrying out the check, wait a short time to allow all oil to drain back into the sump.

Withdraw the dipstick, wipe it clean with a non-fluffy rag, replace and withdraw it again. The oil on the dipstick indicates the oil level in the sump, which should lie between the two marks, Fig. 6. The quantity of oil required to top up from the bottom mark to the top mark is approximately 1,7 litre (3,0 pints).

If necessary, top up through the filler neck, with engine oil to FORD specification.

Topping up is not necessary until the oil level drops to the bottom mark. Do not allow the oil level to drop any further. Never top up to above the top mark since the excess oil is wasted, i.e. the oil consumption is increased.

The engine oil should be changed and the full-flow oil filter renewed at 5000 km (3000 mile) intervals. If conditions of use are severe, e.g. short trips, frequent starts from cold, dusty roads, etc., the oil should be changed and the oil filter renewed at shorter intervals.

If the specified engine oil is not used the inevitable consequence will be excessive wear or damage to the engine. The oil film becomes discontinuous and engine components under high thermal stresses are subjected to increased wear. Residues collect in the sump and block oil passages. In addition, poor quality oil does not protect against corrosion so that rust forms on the cylinder walls. After a relatively short time the efficiency of the engine will decrease and there will be increased fuel and oil consumption. Always use a branded oil complying with FORD specifications.

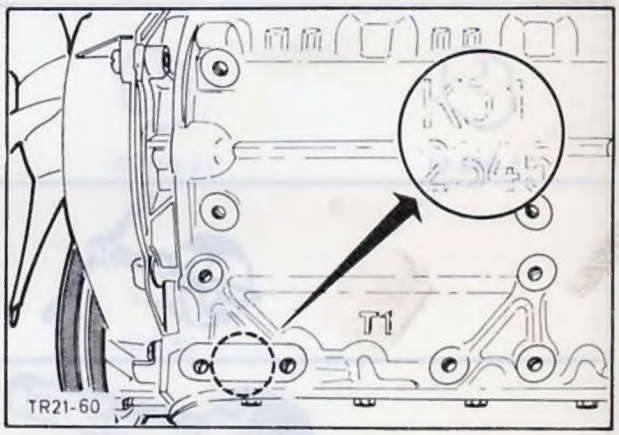


Fig. 5. Engine serial number

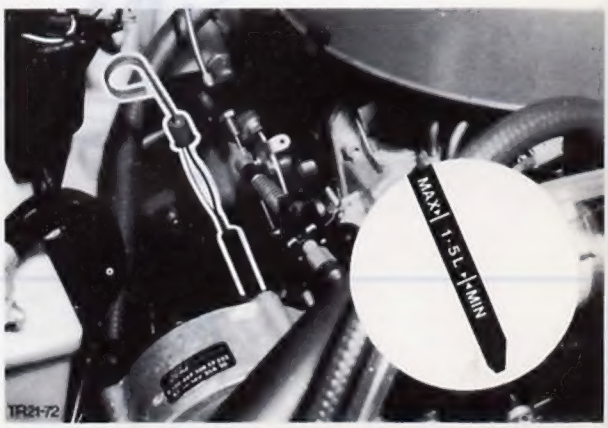
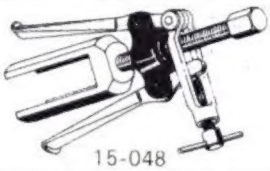
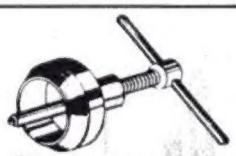
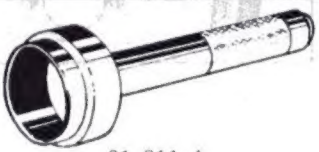
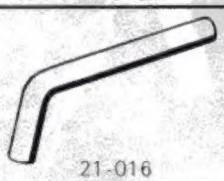


Fig. 6. Engine oil dipstick

SPECIAL SERVICE TOOL RECOGNITION

British Sourced	European Sourced	German Sourced	Tool Name
		G1-6000	Engine lifting eyes (additional for G2–6000)
		G2-6000	Engine lifting tackle
	 15-048	G2-4676-A1	Camshaft oil seal remover
15-048-01	15-048-01	G2-4676-A2	Camshaft oil seal remover adaptor (for use with 15–048)
	 21-010		Crankshaft rear oil seal remover
	 21-011-A		Crankshaft rear oil seal replacer
	21-015		Engine mounting bracket
	 21-016		Timing gear alignment pin
	21-017		Camshaft oil seal replacer and aligner

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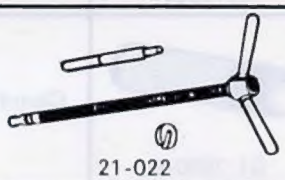
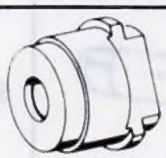
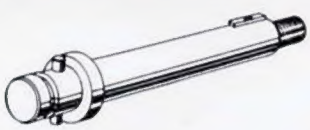
SPECIAL SERVICE TOOL RECOGNITION (cont'd)

British Sourced / European Sourced / German Sourced	Tool Name
21-018	Crankshaft flange holding wrench
21-019	Crankshaft bolt remover and replacer (adaptor for 21–018)
21-021	Valve guide – remover/installer
 21-022	Camshaft bearing remover/installer (main tool)
 21-022-01	Camshaft bearing shell remover/installer (adaptor for 21–022)
21-022-02	Camshaft bearing shell remover/installer (adaptor for 21–022)
 21-023	Universal spindle
21-025	Crankshaft front oil seal aligner
21-026	Engine lifting eye – front

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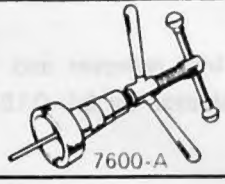
SPECIAL SERVICE TOOL RECOGNITION (cont'd)

British Sourced	European Sourced	German Sourced	Tool Name
	21-027		Engine lifting eye – rear
 7600-A	21-036	G1-7600-A	Spigot bearing remover
CT-9044	21-041	CT-9044	Injector pipe nut wrench
CP-7112-A	21-044	G1-7600-B	Clutch disc locator
CP-7123	21-045	G3-7041-B2	Spigot bearing installer

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SERVICE AND REPAIR OPERATIONS – CONTENT

ENGINE		Description in this publication	Contained in Operation	Unique for TRANSIT
21 111	Engine – check compressions	X		X
21 112	Oil pressure – check	X		X
21 132	Engine and transmission assembly – remove and install	X		X
21 134 8	Engine – dismantle and reassemble (engine removed)	X		X
21 146	Cover-timing belt – remove and install	—	21 288	X
21 148	Timing cover – remove and install	—	21 467	X
21 154	Sump – remove and install	X		X
21 163	Cylinder head – remove and install	X		X
21 213	Valve clearances – adjust	X		X
21 217 4	Valves – remove and install (cylinder head removed)	X		X
21 231 9	Valve seat – recut (valves removed)	X		X
21 235 4	Valve guides – replace (valves removed)	X		X
21 255 9	Rocker shaft assembly – overhaul (rocker shaft removed)	X		X
21 286 6	Bearings – camshaft – replace (engine dismantled)	X		X
21 288	Seal – camshaft – replace	X		X
21 304	Timing belt – replace	X		X
21 467	Seal – crankshaft front – replace	X		X
21 468 4	Seal – crankshaft rear – replace (engine or transmission removed)	X		X
21 505 5	Piston – replace (piston and connecting rod assembly removed)	X		X
21 584 5	Ring gear – flywheel – replace (flywheel removed)	X		X
21 714	Oil pump – remove and install	X		X
21 714 8	Oil pump – overhaul (oil pump removed)	X		X
21 875	Engine rubber mounting – front – replace	X		X

SERVICE AND REPAIR OPERATIONS

21 111 ENGINE – CHECK COMPRESSIONS

Special Service Tools and Testing Equipment Required:

Injection pipe nut wrench 21–041
Standard compression testing equipment

The majority of test instruments are of different design and usually enable compression to be checked on one cylinder only. Determination of the actual compression pressure is dependent on several factors, e.g. varying starter motor speeds, or state of charge of the battery. It is, however, essential for at least two requirements to be met, namely, that the engine temperature is normal and valve clearances are adjusted as specified in Technical Data.

To Check

1. Remove inlet manifold.
2. Disconnect cable from shut-off unit to interrupt fuel supply.
3. Unscrew fuel injector pipes using Special Tool 21–041, Fig. 7 and disconnect overflow pipe from nozzle brackets.
4. Remove injectors and withdraw nozzle bracket sealing ring and heat balancing plate.
5. Screw compression pressure tester with new graph paper to injector nozzle orifice concerned, Fig. 8 and crank engine until pointer of tester rises no further (compression pressure data see Technical Data).
6. Vent tester, adjust graph paper for next cylinder and repeat sub-op 5 for all other cylinders.
7. Fit new sealing ring and new heat balancing plate with domed side facing upwards, Fig. 9 and tighten injector nozzles as specified in Technical Data.
8. Fit injector pipes as specified, using Special Tool 21–041 and install overflow pipe.
9. Connect cable to shut-off motor and fit air cleaner.

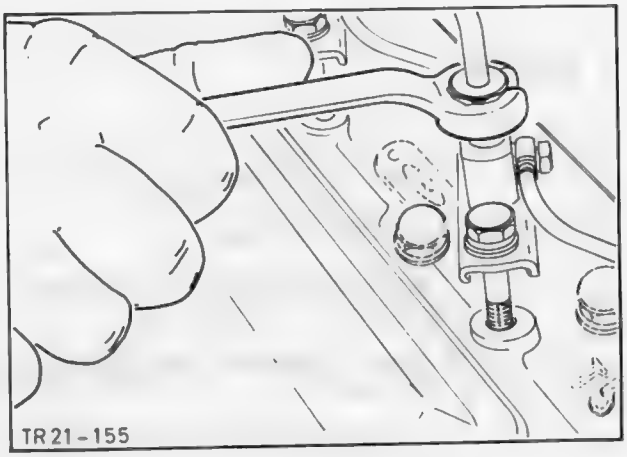


Fig. 7. Remove injector pipes using Special Tool 21–041

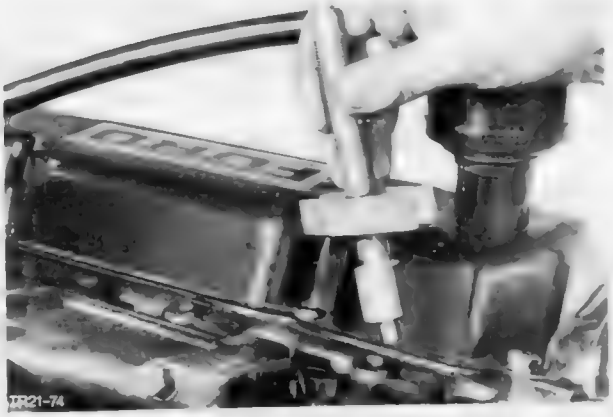


Fig. 8. Install compression tester adaptor into orifice

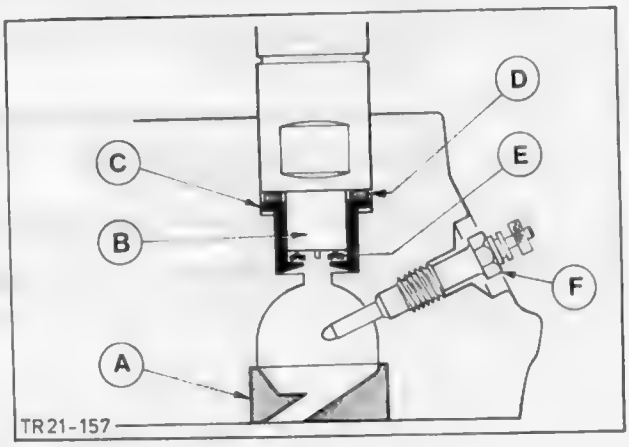


Fig. 9. Turbulence combustion chamber
A – Turbulence combustion chamber element
B – Engine heat shield
C – Engine heat shield gasket
D – Nozzle bracket sealing ring
E – Heat balancing plate

21 112 OIL PRESSURE – CHECK

Testing equipment required:

Oil pressure test gauge

Oil pressure depends on various factors (engine speed, oil temperature, oil pump rotor clearance, etc.). Pressure should always be checked at an oil temperature of 355 °K (80 °C) (176 °F). At idling speed oil pressure should be 1,0 bar (kgf/cm²) (14,2 lbf/in²). Maximum pressure should however, not exceed 5 bar (kgf/cm²) (71 lbf/in²) at speeds above 2000 rpm.

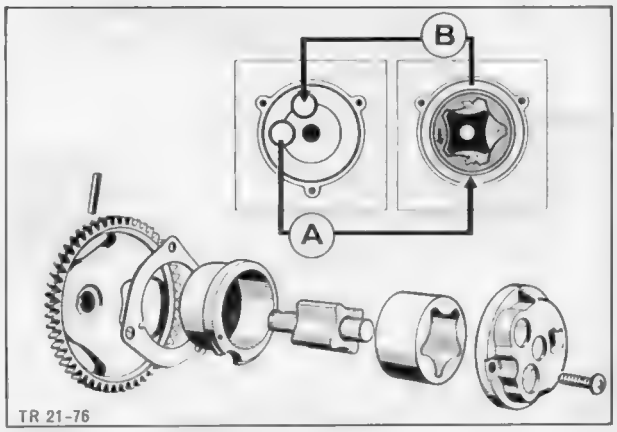


Fig. 10. Oil pump dismantled
A – Suction pipe
B – Pressure pipe

If pressures are outside these limits first eliminate oil pump, Fig. 10 or relief valve, Figs. 11 and 12, as possible sources of fault. The following faults can occur, e.g.:

Pressure too high at speeds over 2000 rev/min; Failure of relief valve to open because of fouling.

Pressure too low at all engine speeds: Clogged intake strainer, intake pipe loose or broken, oil pump worn, etc.

Pressure too low at low engine speeds: Relief valve jammed in open position due to dirt.

Fig. 11. Relief valve location (vacuum pump removed for clarity)

To measure oil pressure

1. Remove oil pressure switch connecting lead and remove oil pressure switch.
2. Connect test pressure gauge to engine block, using adaptors, if necessary.
3. Start engine and check oil pressure at idling speed and at over 2000 rev/min.
4. Remove test pressure gauge. Replace oil pressure switch and connect lead as specified in Technical data.

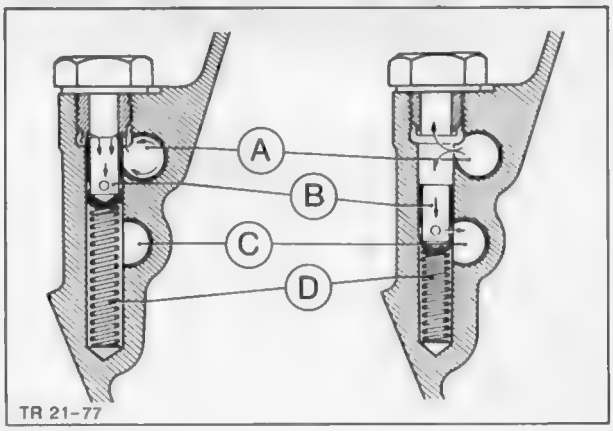


Fig. 12 Relief valve
A – Pressure pipe
B – Suction pipe
C – Valve plunger
D – Compression spring

21 132 ENGINE AND TRANSMISSION ASSEMBLY – REMOVE AND INSTALL

Special Service Tools Required:

Engine lifting eyes	G1–6000
Engine lifting tackle	G2–6000
Engine lifting eye – front	21–026
Engine lifting eye – rear	21–027

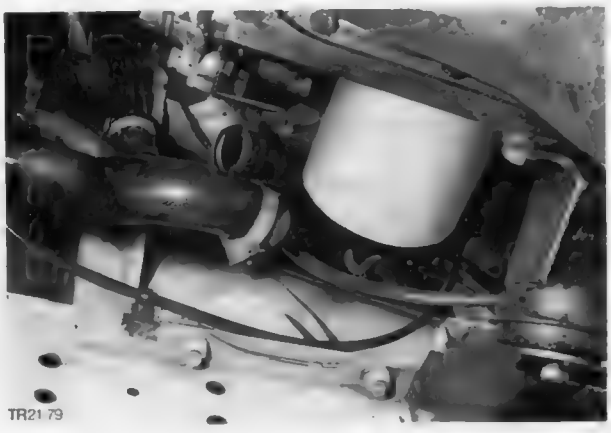


Fig. 13. Drain coolant

To Remove

1. Disconnect both battery earth cables, as well as positive lead from left-hand battery.
2. Disconnect washer assembly hoses from nozzles and retaining clamps and remove hood (4 bolts).
3. Drain coolant into tray, disconnecting lower radiator hose from water neck, Fig. 13, and upper hose from thermostat water neck and remove.
4. Remove coolant expansion tank connecting pipe (2 bolt), Fig. 14 and remove expansion tank complete with bracket from engine (3 bolts).

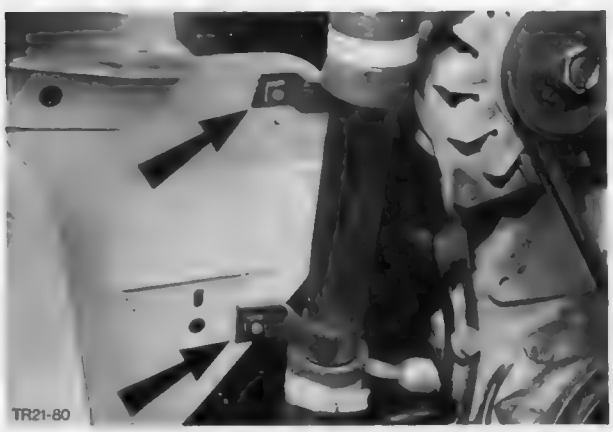


Fig. 14. Unscrew expansion tank connecting pipe

5. Disconnect radiator (2 bolts) bottom mounting from crossmember mountings, Fig. 15.

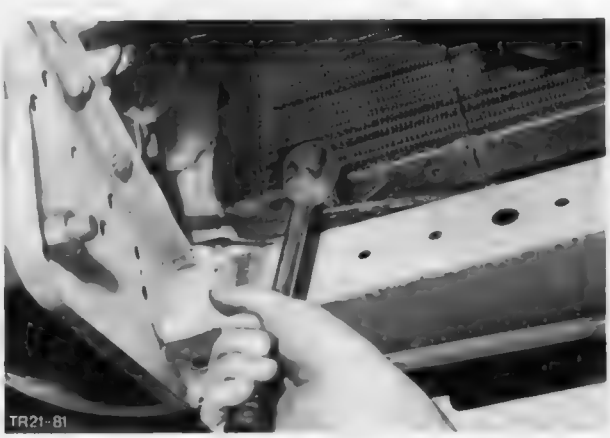


Fig. 15. Remove radiator bottom mounting from crossmember

6. Unhook hood cable at catch end (Fig. 16) and disconnect from radiator grille panel.

Fig. 16. Unhook hood cable

7. Remove right-hand and left-hand headlamp surround (1 bolt each).
8. Remove radiator grille panel complete with radiator and expansion tank, as well as connecting pipe, Fig. 17.

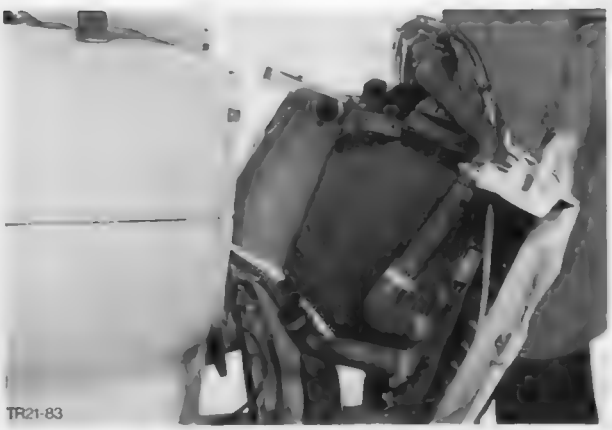


Fig. 17. Remove radiator grille panel complete with radiator, expansion tank and connecting pipe

9. Remove air cleaner (2 bolts).
10. Disconnect cables from shut-off motor and injection pump, Fig. 18.

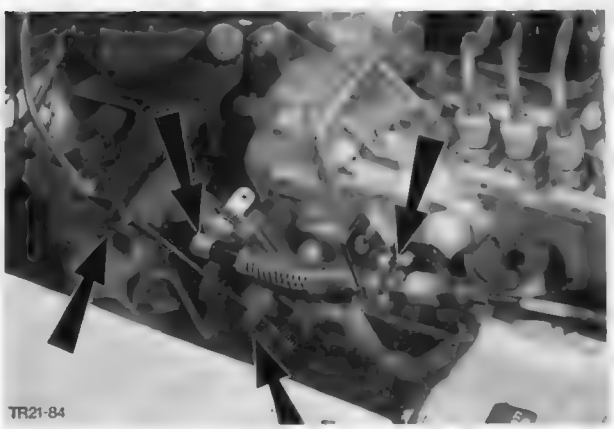


Fig. 18. Disconnect shut-off motor and injection pump cables

21 132 (cont'd)

11. Disconnect fuel feed and return line from pump and remove fuel filter and thermostart reservoir lines from intake manifold.
12. Disconnect temperature sender unit, oil pressure switch, glow plugs, starter motor and alternator. Remove positive left-hand battery cable from body.
13. Disconnect brake servo vacuum hose from pipe and remove, Fig. 19.

Fig. 19. Remove brake servo vacuum hose

14. Remove water drain neck and heater hoses from splash panel, Fig. 20.

Fig. 20. Remove heater hoses

15. Disconnect exhaust pipe from manifold (2 bolts).
16. Remove transmission gearshift lever mounting bracket (6 bolts) and raise gaiter. Remove gear shift lever cap nut, Fig. 21 and withdraw gearshift lever.

Fig. 21. Remove transmission gearshift lever nut

17. Remove clutch cable from pedal bracket, Fig. 22.

Fig. 22. Remove clutch cable from pedal bracket

18. Disconnect left-hand and right-hand earth cables from clutch housing and remove speedometer drive cable from transmission (1 bolt), Fig. 23.

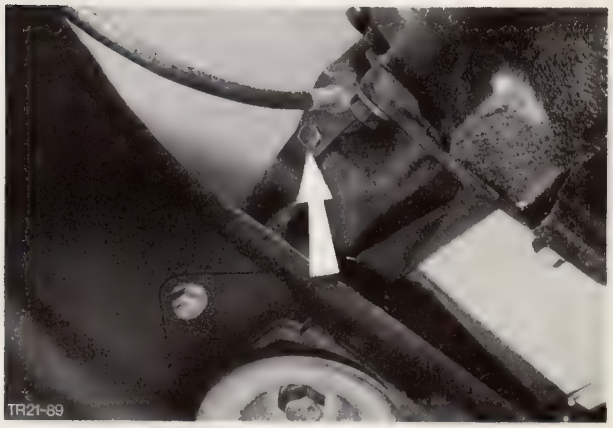


Fig. 23. Remove speedometer drive cable

19. Pull back gaiter and unhook clutch cable from release lever, Fig. 24.

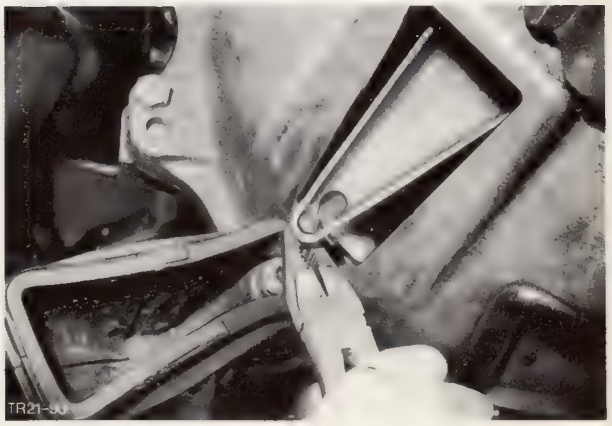


Fig. 24. Unhook clutch cable from release lever

21 132 (cont'd)

20. Disconnect drive shaft at rear axle flange (4 bolts), Fig. 25 and floor pan centre bearing (2 bolts), withdraw drive shaft from gearbox extension housing and fit blanking plug.

Fig. 25. Remove driveshaft

21. Attach engine lifting eyes 21–026/27 to engine, Fig. 26 and fit engine lifting appliance G2–6000 with engine lifting eye G1–6000.
22. Hook engine lifting appliance into standard workshop lifting jack and gently take up engine weight.

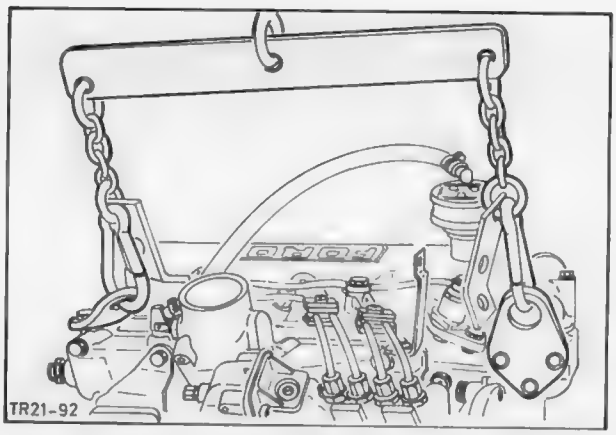


Fig. 26. Fit engine lifting eyes and lifting chain

23. Remove transmission from rear engine mounting (1 bolt), Fig. 27 and engine from mounting rubber insulator (2 nuts).
24. Carefully raise engine complete with transmission and lift out of engine compartment.

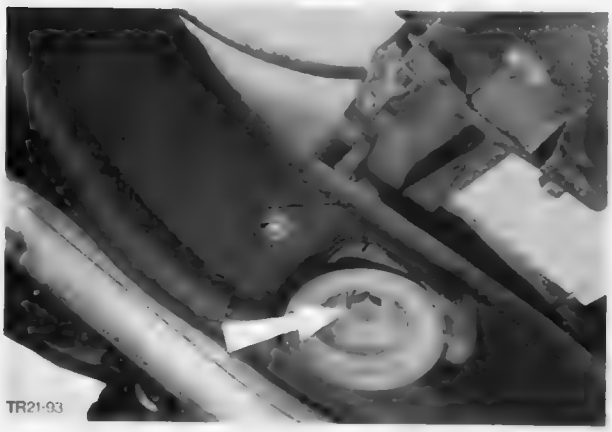


Fig. 27. Remove transmission from rear engine mounting

To Install

25. Carefully position engine complete with gearbox in engine compartment and fit on front and rear engine mounting. Tighten as specified in Technical data.
26. Remove engine lifting appliance.
27. Withdraw blanking plug from gearbox extension housing, carefully insert driveshaft and attach to rear axle flange and centre bearing as specified in Technical data, Fig. 28.

Fig. 28. Fit driveshaft centre bearing

28. Connect speedometer drive cable. Hook clutch cable into release lever and install gaiter. Fit earth cable left and right to clutch housing and attach left-hand battery positive lead to body.
29. Adjust clutch cable clearance at pedal bracket, Fig. 29.

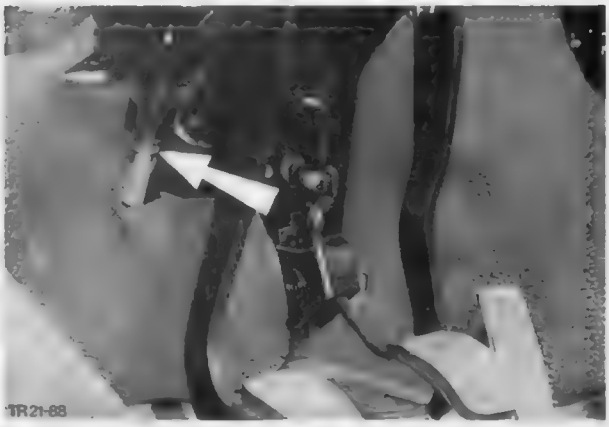


Fig. 29. Adjust clutch cable clearance

30. Install gearshift lever and tighten nut. Locate gaiter and fit mounting bracket.
31. Bolt exhaust pipe to manifold.
32. Fit heater hoses and water drain neck, Fig. 30.

Fig. 30. Fit water drain hose

21 132 (cont'd)

33. Slide brake servo vacuum hose on to line and secure, Fig. 31.
34. Connect leads to temperature sender unit, oil pressure switch, glow plugs, starter motor and alternator.

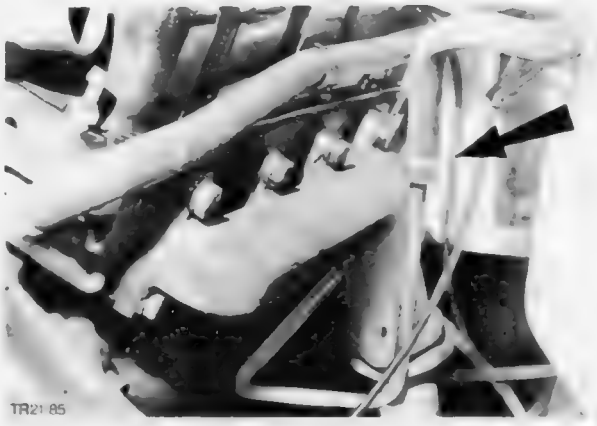


Fig. 31. Slide brake servo vacuum hose on to line and secure

35. Connect fuel filter and thermostart reservoir pipes to inlet manifold and fit fuel feed and return lines to pump.
36. Fit fuel injection pump and shut-off motor cables, then bleed the fuel system – refer to Op. 23 142, Fig. 32/33.

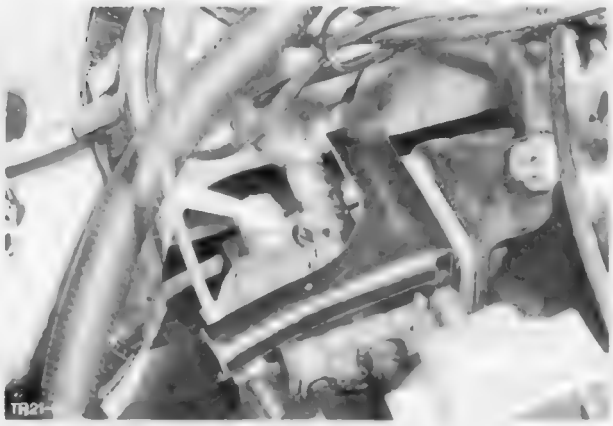


Fig. 32. Vent fuel-filter

37. Fit air cleaner.

Fig. 33. Vent fuel pump

38. Insert radiator grille panel complete with radiator and expansion tank and secure, Fig. 34. Fit both headlamp surrounds.

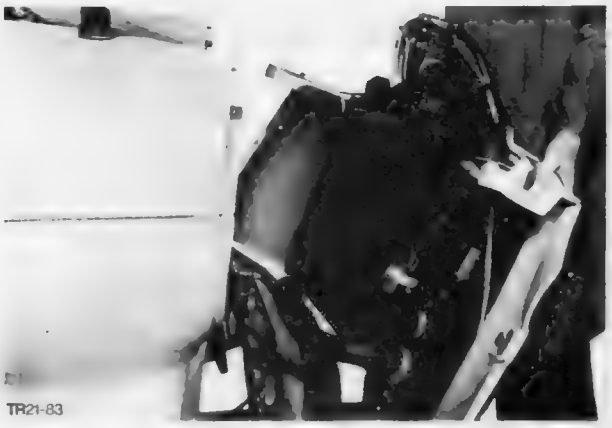


Fig. 34. Install radiator grille panel complete with radiator. connecting pipe and expansion tank

39. Hook hood cable into catch, Fig. 35 and fit to radiator grille panel.

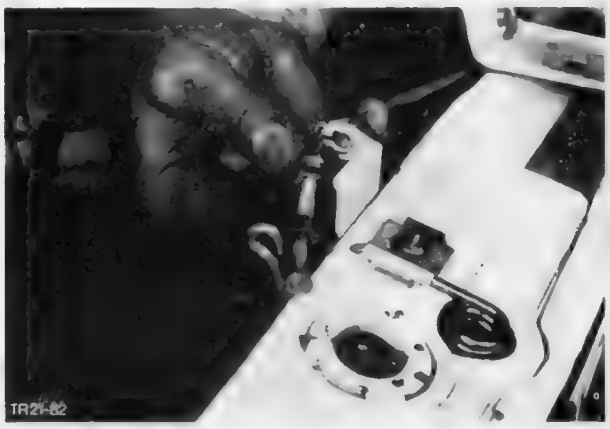


Fig. 35. Fit hood cable

40. Replace radiator at bottom location to cross-member mountings, Fig. 36.

Fig. 36. Fit radiator at bottom location

21 132 (cont'd)

41. Fit expansion tank with bracket to engine, Fig. 37 and attach expansion tank connecting pipe.

Fig. 37. Fit expansion tank

42. Replace lower and upper radiator hoses and secure, Fig. 38.

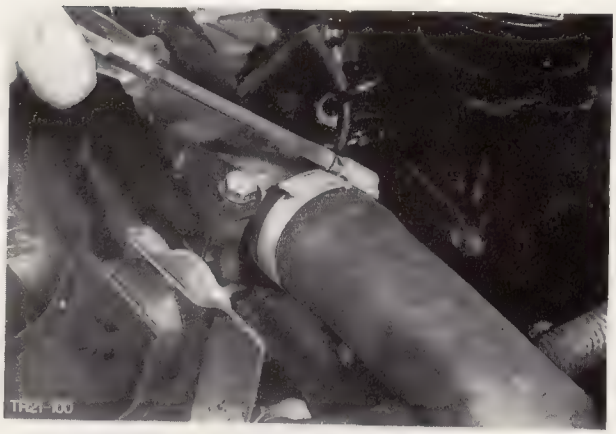


Fig. 38. Fit upper radiator hoses and secure

43. Top up coolant and engine oil. Check transmission oil level and top up, if required.
44. Position hood, hand-tighten bolts, align hood and secure. Position washer system hoses, Fig. 39 and slide on to nozzles.
45. Connect earth cables to both batteries and positive lead to left-hand battery.

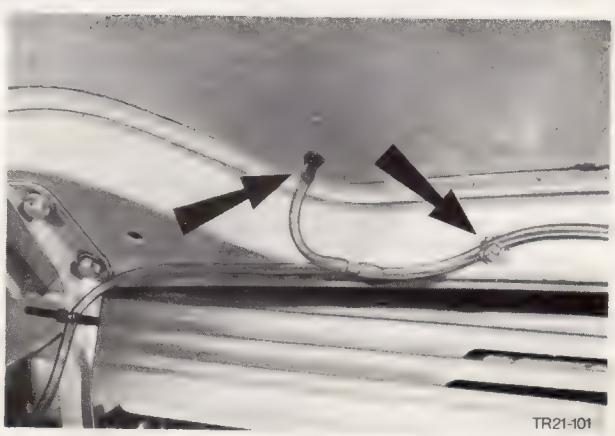
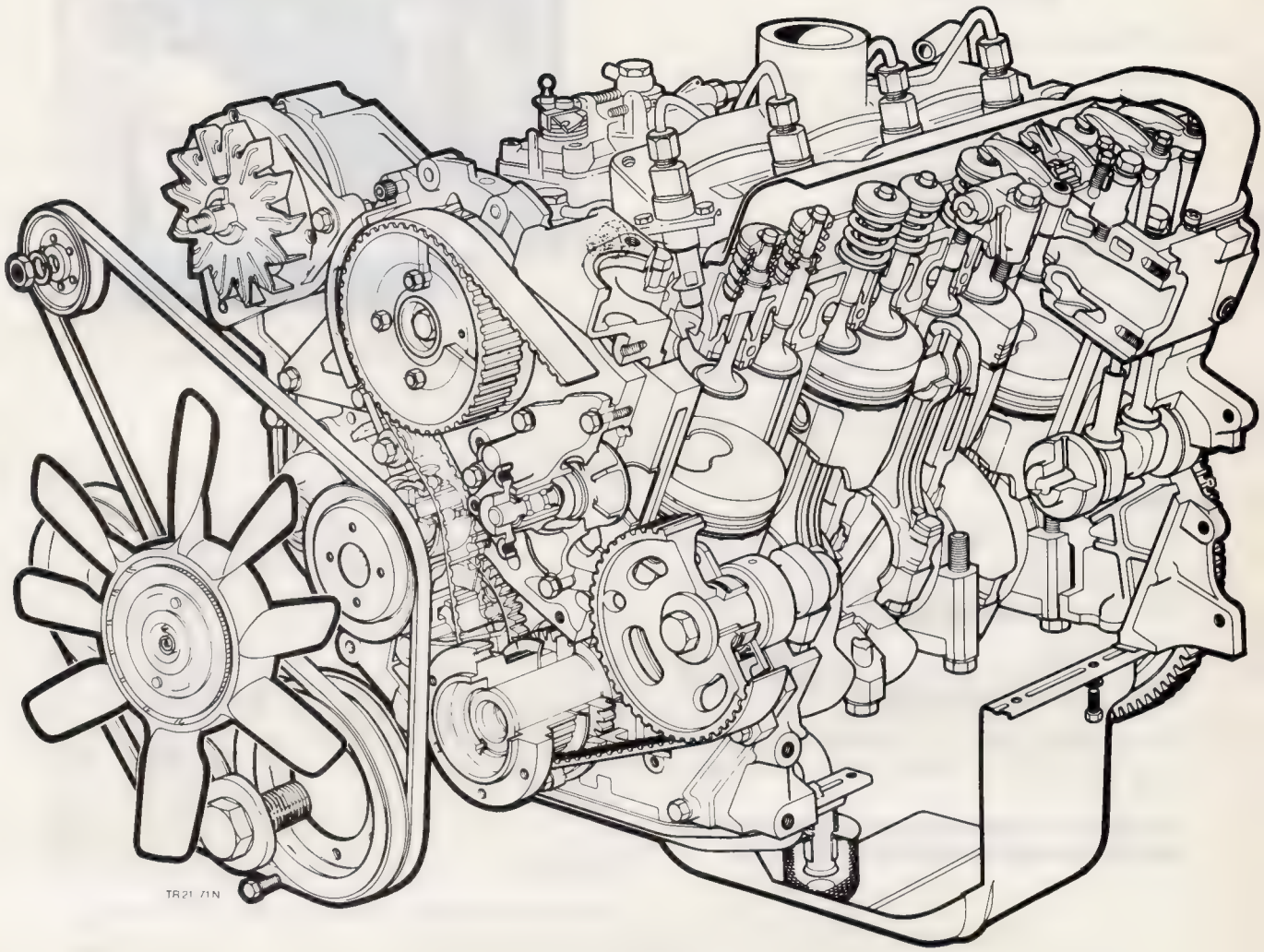


Fig. 39. Position washer system hoses

21 134 8



TR 21-71

Fig. 40. 'G' Engine cutaway

21 134 8 ENGINE – DISMANTLE AND REASSEMBLE (ENGINE REMOVED)

Special Service Tools Required:

Crankshaft rear oil seal installer	21–011–A
Engine mounting bracket	21–015
Camshaft gear alignment pin	21–016
Camshaft oil seal installer	21–017
Crankshaft flange holding wrench	21–018
Crankshaft bolt remover/replacer	21–019
Universal shaft	21–023
Crankshaft front oil seal centraliser	21–025
Crankshaft spigot bearing extractor	21–036
Injector pipe nut wrench	21–041
Clutch disc centraliser	21–044
Crankshaft spigot bearing installer	21–045
Engine stands	21–061–A/B/C/D

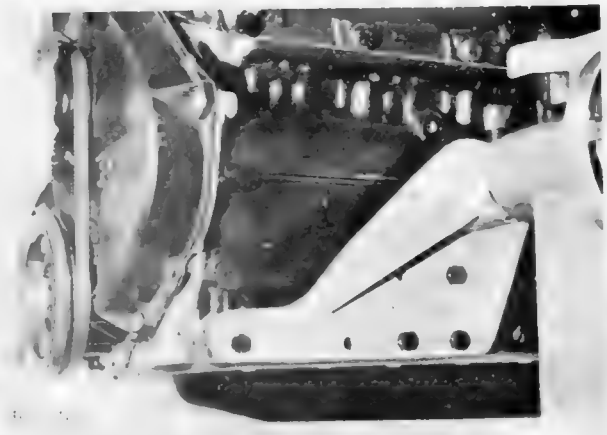


Fig. 41 Secure engine to stand, using Special Tools

To Dismantle

1. Remove front left-hand engine mounting rubber insulator, then fit engine stand(s) 21–061–A/B/C/D using mounting bracket 21–015 and universal shaft 21–023, Fig. 41.
2. Drain engine oil, withdraw oil dipstick and unscrew full-flow oil filter cartridge. Remove oil filler cap with breather hose.
3. Using special tool 21–041 remove overflow pipe from nozzles, injection pump and injector lines, Fig. 42.

   Fit caps to nozzle and pump line connectors for protection from contamination.

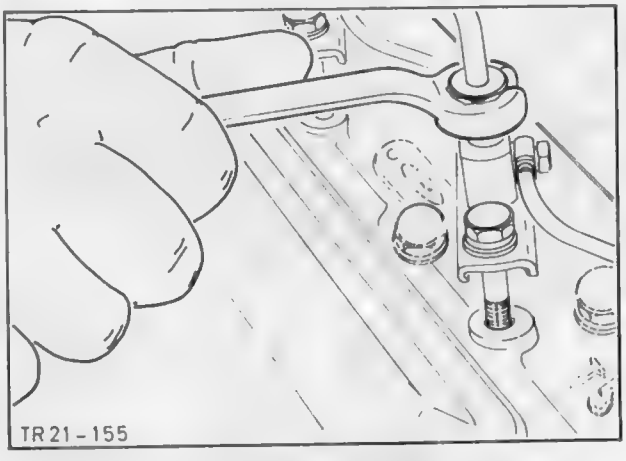


Fig. 42 Unscrew injector lines using Special Tool 21–041

4. Remove injection pump filter fuel lines and engine vacuum pump air line.
5. Remove fuel filter complete with bracket (3 bolts), Fig. 43.

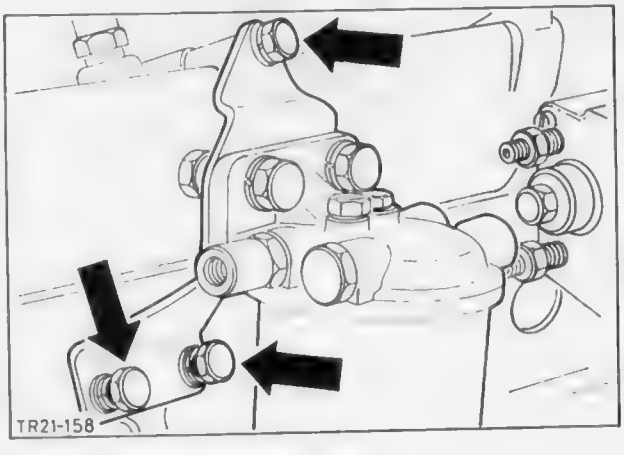


Fig. 43. Remove fuel filter with bracket

6. Slacken vacuum pump V-belt tension roller Fig. 44 and alternator V-belt adjuster, then remove both V-belts.
7. Remove alternator complete with bracket (4 bolts).
8. Remove fan with pulley (4 bolts).
9. Remove crankshaft pulley (6 bolts).

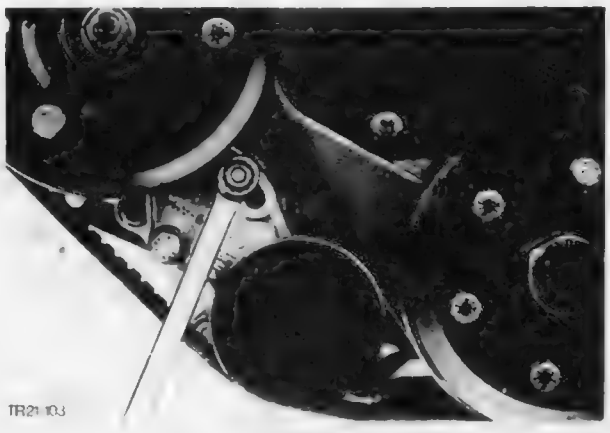


Fig. 44. Slacken vacuum V-belt tension roller

10. Remove upper and lower toothed belt cover bolts and remove cover, Fig. 45.
11. Remove rocker cover (6 bolts).
12. Remove three lower then five upper rocker support bracket bolts. Remove rocker shaft and withdraw push rods.

    Do not interchange push rods when removing and installing.

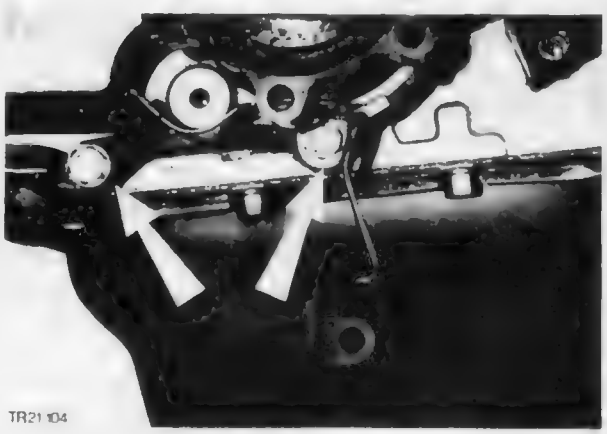


Fig. 45. Remove lower toothed belt cover

13. Remove injector nozzles (2 bolts each), then lift out nozzle holder sealing rings and heat balancing plate. Withdraw heat shields and gaskets, using 2 screwdrivers.
14. Remove water neck (2 bolts) and lift out thermostat, noting location, Fig. 46.

Fig. 46. Remove thermostat

21 134 8 (cont'd)

15. Slacken water pump to cylinder head by-pass hose, Fig. 47.
16. Remove cylinder head bolts (18), unscrewing them in reverse order from that in which they were tightened (for tightening sequence see Fig. 90). Lift off cylinder head complete with inlet and exhaust manifolds.

    Do not place cylinder head on gasket face.
17. Remove clutch pressure plate (6 bolts) flywheel (8 bolts), and engine backplate (2 bolts).

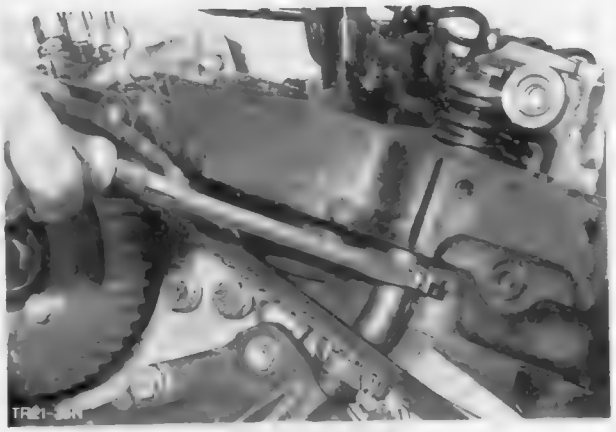


Fig. 47. Slacken by-pass hose

18. Remove sump (24 bolts) downwards to prevent sludge or swarf getting into engine.
19. Slacken toothed belt tensioner and remove toothed belt, Fig. 48, then remove tensioner (2 bolts).

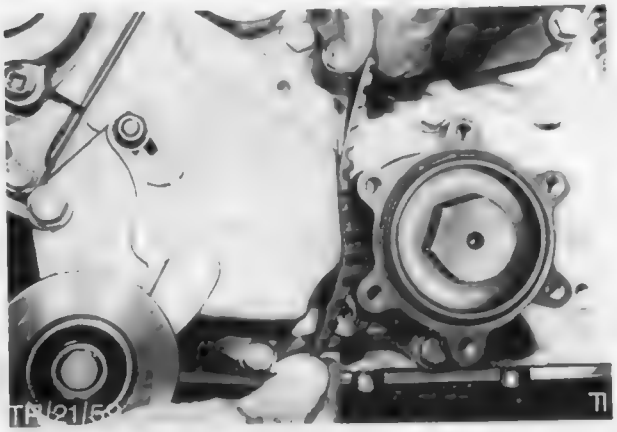


Fig. 48. Remove toothed belt

20. Remove crankshaft hub bolt, using Special Tool 21–018/019, Fig. 49. Remove crankshaft hub using standard extractor.

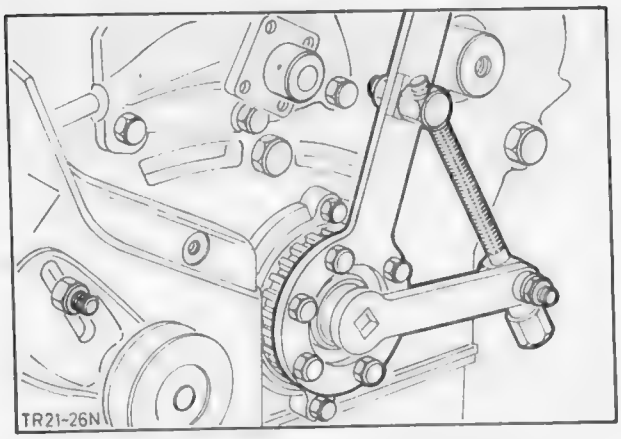


Fig. 49. Slacken crankshaft hub bolt using Special Tool 21 -018/019

21. Lock camshaft toothed belt gear with Special Tool 21–016, Fig. 50. Unscrew bolt and press off gear using two levers.

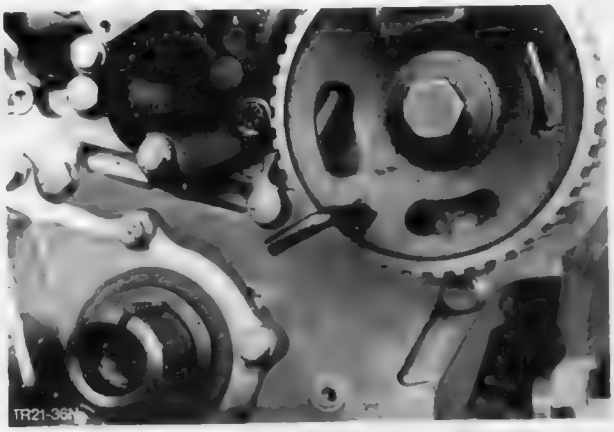


Fig. 50. Lock camshaft toothed belt gear using Special Tool 21–016

22. Remove water pump with by-pass hose from intermediate plate (7 bolts), Fig. 51.

Fig. 51. Remove water pump

23. Remove vacuum pump pulley, Fig. 52, using standard extractor if necessary.

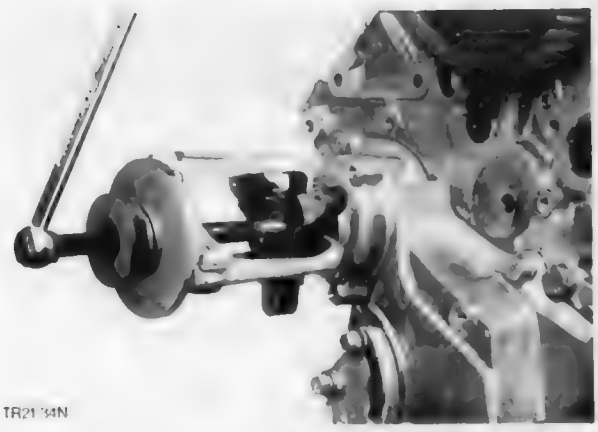


Fig. 52. Remove vacuum pump pulley

21 134 8 (cont'd)

24. Remove front cover from intermediate plate (10 bolts).
25. Remove oil pump with mounting (3 bolts) from engine block, Fig. 53.

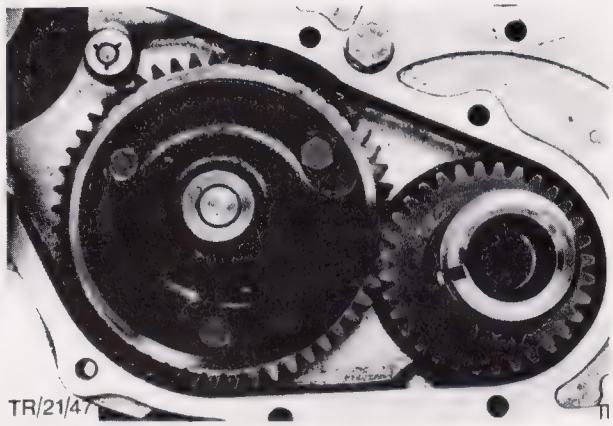


Fig. 53. Remove oil pump

26. Remove vacuum pump bracket and pump from intermediate plate (3 bolts) Fig. 54.

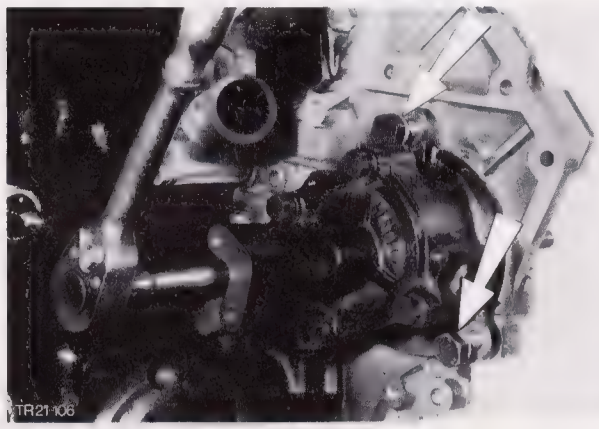


Fig. 54. Remove vacuum pump

27. Remove injection pump bracket from engine block (2 bolts), then remove intermediate plate complete with injection pump (10 bolts), Fig. 55.

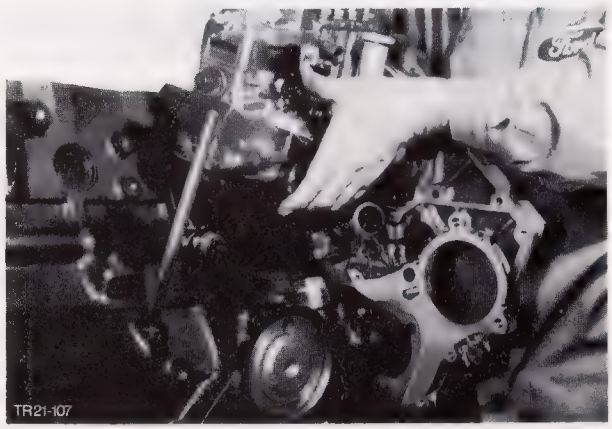
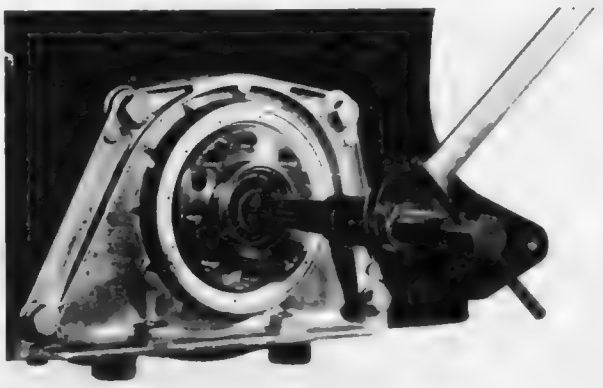


Fig. 55. Remove injection pump and intermediate plate

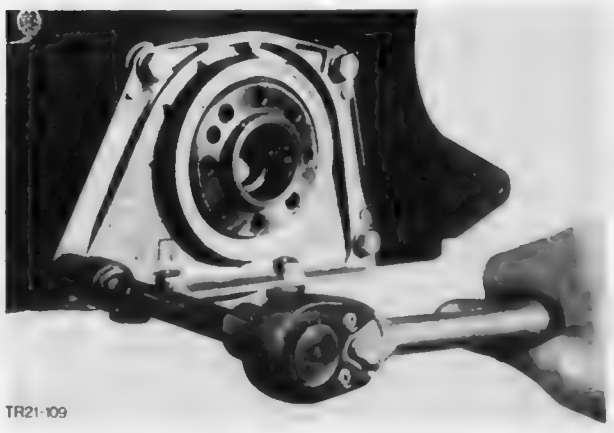
28. Remove camshaft and crankshaft spacer, as well as crankshaft gear, by hand.
29. Withdraw crankshaft spigot bearing, using Special Tool 21–036, Fig. 56.



TR21-108

Fig. 56. Remove crankshaft needle bearing using Special Tool 21–036

30. Remove crankshaft rear oil seal carrier (4 bolts), Fig. 57.
31. Remove camshaft rear cover plate bolts (3) and camshaft thrust plate bolts (2), Fig. 58. Remove plates and carefully withdraw camshaft.

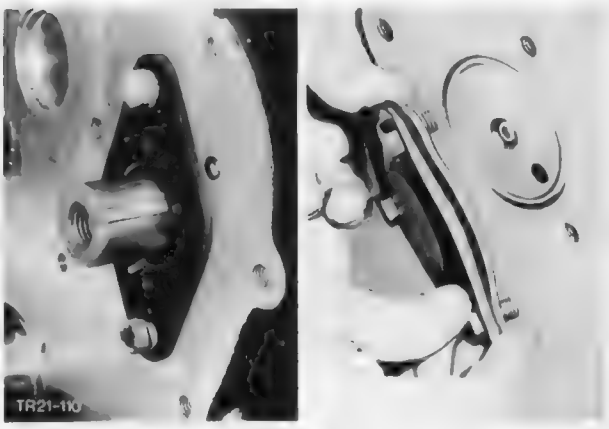


TR21-109

Fig. 57. Remove crankshaft oil seal carrier

32. Remove tappets from engine block.

    Do not interchange tappets when removing and installing.
33. Remove oil pump suction pipe (2 bolts).



TR21-110

Fig. 58. Remove camshaft thrust plate

21 134 8 (cont'd)

34. Remove big end bearing caps (2 nuts each) and bearing shells.

Note connecting rod, bearing cap and bearing markings.

Fig. 59. Big end journal markings

35. Carefully scrape off carbon deposits from cylinder bore top ends, then withdraw piston and connecting rod assemblies upwards from the block. Remove piston rings, clean grooves and fit new rings into grooves, with 'TOP' mark pointing upwards, Fig. 60.

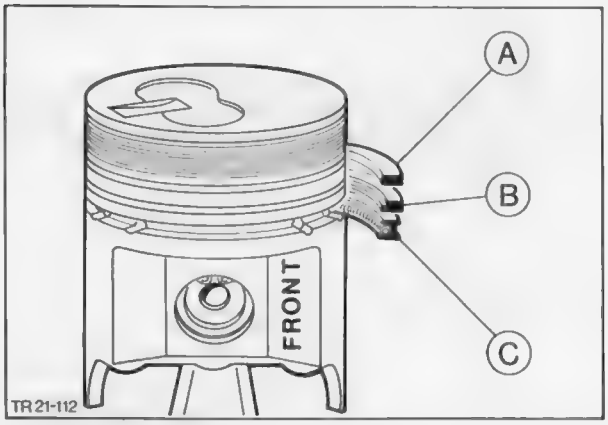


Fig. 60. Fit piston rings
A – Upper piston ring
B – Lower stepped ring
C – Oil scraper ring

36. Remove main bearing caps (2 bolts each) and shells. Note centre main bearing thrust washers.

Note bearing shell and cap markings, Fig. 61.

37. Carefully lift crankshaft out of engine block.

38. Remove oil pressure switch and pressure relief valve.

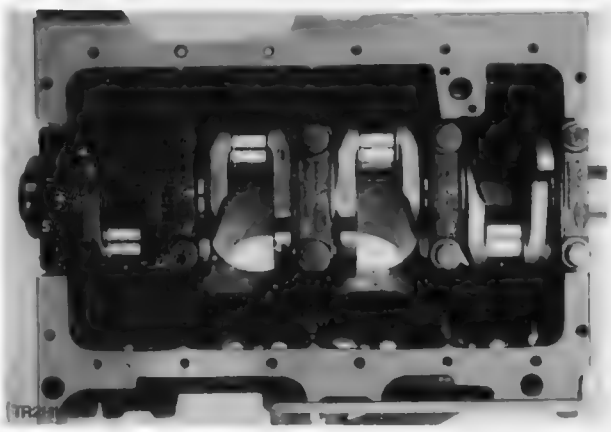


Fig. 61. Main bearing markings

To Reassemble

The type and degree of cleaning of a given part before reassembly must depend on the hours the engine has run, the extent of any damage and its possible re-use. This applies particularly to the cylinder block with its corners, angles and bores. If necessary, remove all plugs and covers and clean their seats, using suitable cleaning agents and tools (brushes, scrapers). The oil galleries in particular, e.g. in the cylinder block, cylinder head, etc., should be free from dirt and abrasive particles, Fig. 62. If press-fit plugs and screw plugs are removed, they, like all seals and gaskets, should be renewed.

Measuring Bearing Clearance

Measuring bearings (even with undersize crankshafts) can be eliminated and determination of required bearing shells can be considerably simplified by use of:

'PLASTIGAGE' made by:
PERFECT CIRCLE CORPORATION,
HAGERSTOWN, INDIANA, USA.

UK supplier:
Norman Gaydon (International) Ltd.,
68 London Road,
Southend-on-Sea,
Essex, SS1 1PG.

West German supplier:
K. H. ERN,
Schinkelstrasse 46–48,
Dusseldorf.

'PLASTIGAGE' is the name of an accurately calibrated plastic filament.

Type	Colour	Measuring range
PG-1	green	0,025–0,075 mm (0,001–0,003 in)
PR-1	red	0,050–0,150 mm (0,002–0,006 in)
PB-1	blue	0,100–0,230 mm (0,004–0,01 in)

Requirements for use of 'Plastigage'

1. Bearing should be dry and clean.
2. Crankshaft should not be turned during measuring operation.
3. Points of measurement should be close to top dead centre position.
4. Bearing caps should not be seated with hammer blows.

Place length of Plastigage across width of bearing on crankshaft or big end journal. Fit main or big end bearing cap together with bearing shells and torque as specified. The plastic filament will be compressed more or less depending on bearing clearance. Remove bearing cap.

Each main bearing should be measured separately without other bearing caps being fitted.

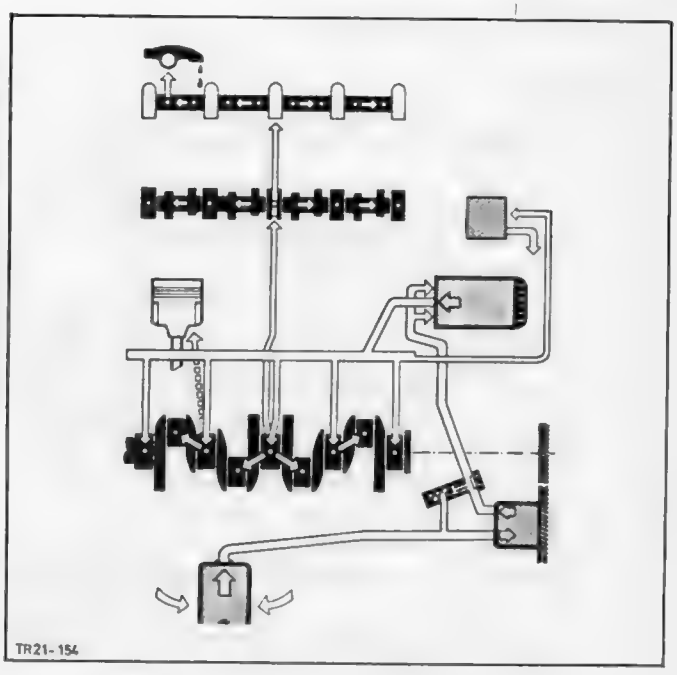


Fig. 62. Oil circuit

Width of compressed plastic filament can be measured by means of scale printed on PLASTIGAGE pack, Fig. 63; reading shows bearing clearance.

Only bolts in good condition should be used for securing bearing caps on crankshaft and they should not be tightened in excess of specified torque.

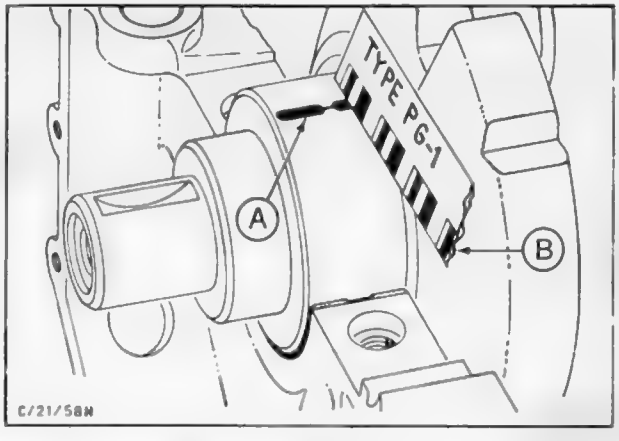


Fig. 63. Measuring bearing play
A – Compressed plastic thread
B – Measurement scale

23 134 8 (cont'd)

Measuring Piston Clearance

Procedure

(a) When re-assembling an engine, the piston to bore clearance should be measured as follows.

(b) The diameter of the piston should be measured when cold, using a micrometer. The measurement should be made across the piston skirt, at 90° to the piston axis.

(c) This micrometer reading is then used to 'zero' a bore gauge. The reading on the dial of the bore gauge in situ is the piston to bore clearance. (See Technical Data.)

Alternatively, the bore can be measured with an internal micrometer, and the piston size subtracted to give the piston to bore clearance.

(d) The measurement must be taken below any visible wear marks in the bore. To detect bore ovality, two readings should be taken at 90° to each other.

NOTE: The maximum difference between these two readings should not be more than 0,025 mm (0,001 in).

(e) Inspect the bores for visible wear, damaged lips, etc.

(f) If the clearance in sub-section (c) above is excessive, or if ovality, or any of the faults in sub-section (e) above is detected, the block should be rebored to suit oversize pistons.

(g) Before installing pistons, check piston ring gaps. (Fig. 64).

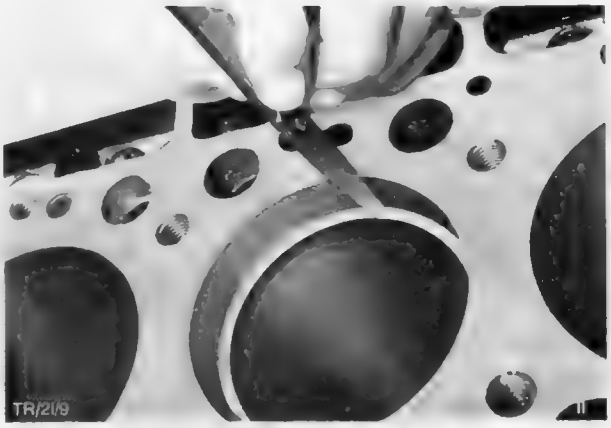


Fig. 64. Check piston ring gap

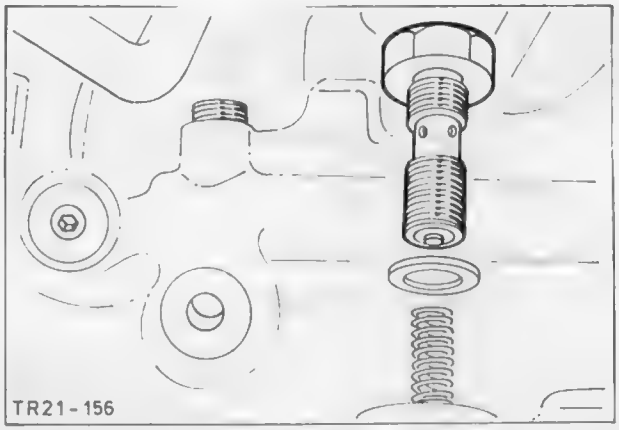


Fig. 65. Fit oil pressure switch

39. Fit oil pressure switch. Lubricate oil pressure valve tappets and fit valve assembly, Fig. 65.

40. Insert main bearing shells dry into engine block, on centre bearing locate both thrust washers in cylinder block recesses in such a manner that oilways are visible (Fig. 66). Lubricate bearing shells and carefully insert crankshaft.

Fig. 66. Fit thrust washers

41 (a) Refit main bearing cap complete with lubricated bearing shells, again paying attention to correct location of thrust half washers on centre main bearing cap, Fig. 67. Tighten bearing cap bolts as specified in Technical Data.

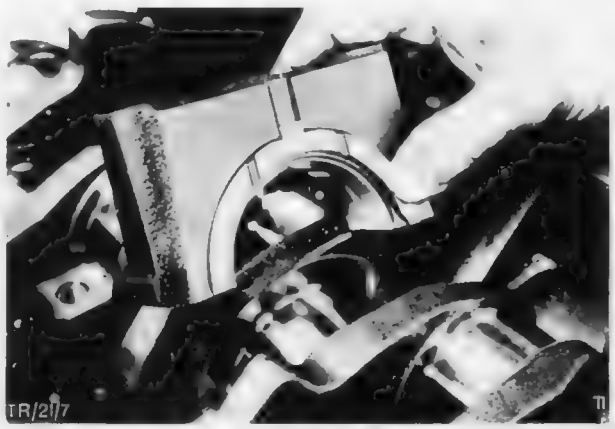


Fig. 67. Fit centre bearing with thrust washers

(b) Fit centre main bearing cap bolts finger-tight only. Press crankshaft first to rear against stop, then slowly and firmly against front stop and hold in position and torque bolts, Fig. 68. (This operation is necessary to ensure uniform seating of thrust washers.)

Main bearing caps should be fitted with arrow pointed forward.

Fig. 68. Align thrust washers

42. Check crankshaft end float using standard dial indicator, Fig. 69. Use oversize thrust washers, if necessary.

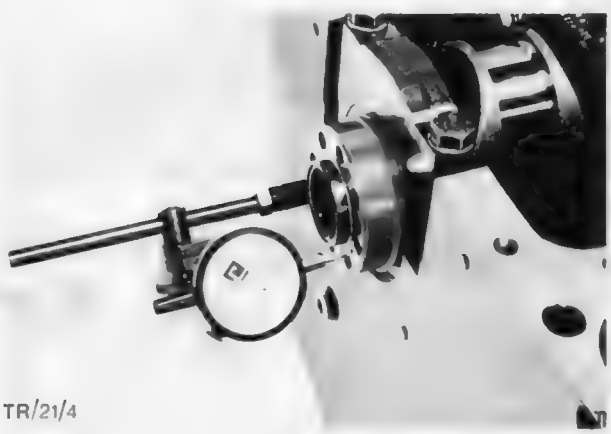


Fig. 69. Check crankshaft end float

21 134 8 (cont'd)

43. Apply engine oil to pistons and cylinder bores. Stagger piston rings with maximum spacing. Compress piston rings with standard ring compressor and press pistons into cylinders using hammer handle, Fig. 70, guiding connecting rods with oiled bearing shells on to big end journals by hand.

    Front marking on pistons and connecting rods should point forward.

44. Fit big end bearing caps complete with oiled bearing shells and torque new self-locking bolts as specified in Technical Data.

    Marks on connecting rods and bearing caps should be on one side.

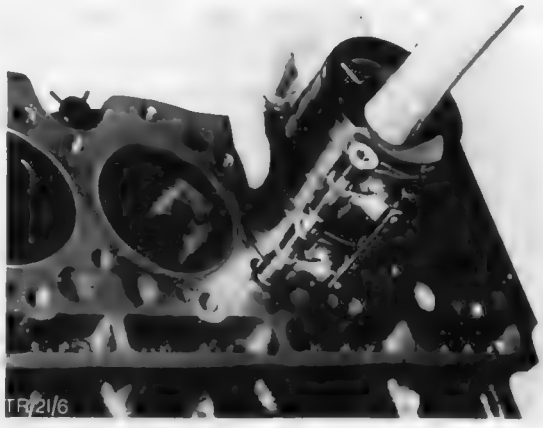


Fig. 70. Fit piston using standard ring compressor

45. Oil valve tappets and fit into same bores as on removal. Oil and carefully insert camshaft, paying attention to correct location of camshaft oil gallery sealing balls. Fit cover plate and thrust plate.

Fig. 71. Press in crankshaft rear oil seal using Special Tool 21-011-A

46. Replace crankshaft rear oil seal:
    Drive oil seal from oil seal carrier using hammer and mandrel, slightly oil sealing lip of new oil seal and carefully drive into oil seal carrier, using Special Tool 21–011–A, Fig. 71. Then fit oil seal carrier and new oil seal, centralise with same Special Tool and secure, Fig. 72.

    Check correct location of oil seal carrier on sump sealing surface.

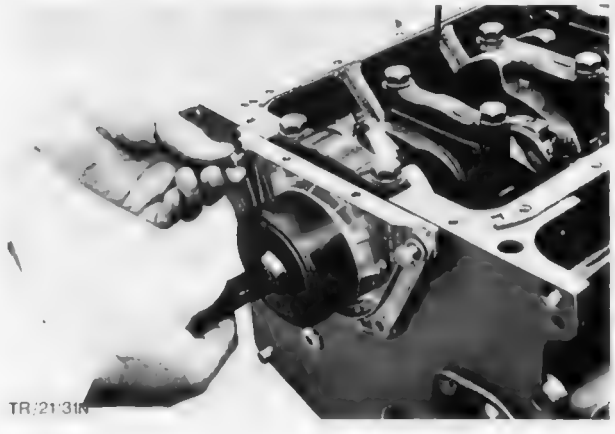


Fig. 72. Centralise rear oil seal carrier using Special Tool 21-011-A

47. Fit oil pump suction pipe with new gasket.

48. Fit crankshaft needle bearing using Special Tool 21–045, Fig. 73.

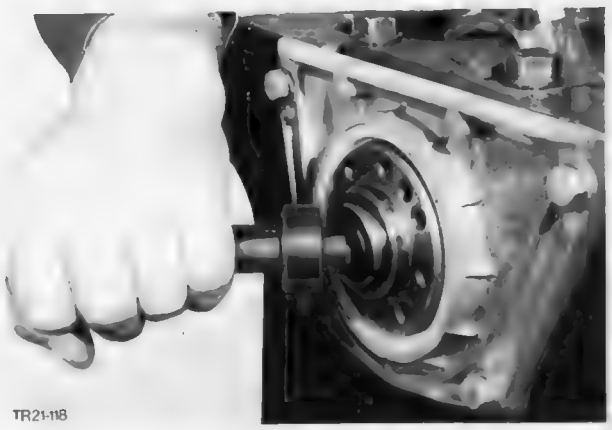


Fig. 73. Fit crankshaft needle bearing using Special Tool 21–045

49. Fit crankshaft gear.

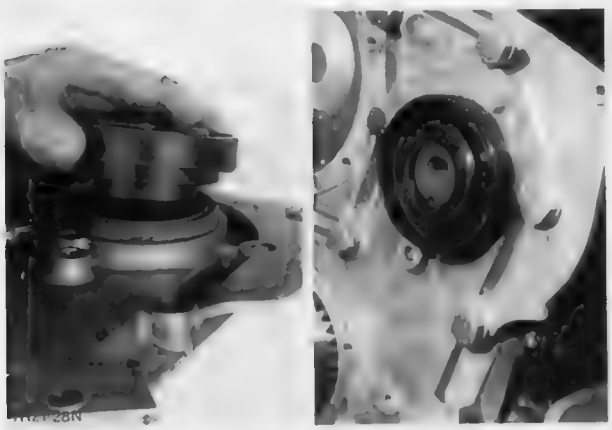


Fig. 74. Fit camshaft oil seal in intermediate plate using Special Tool 21–017

50. Replace camshaft oil seal:
Drive oil seal from intermediate plate using hammer and mandrel, slightly oil sealing lip of new oil seal and carefully draw into intermediate plate using Special Tool 21–017 with bolt and washer, Fig. 74. Then fit intermediate plate with new gasket complete with injection pump (also with new O-rings), centralise with same Special Tool, fit bolts in correct sequence as specified in Technical Data, Fig. 75.

Check correct location of intermediate plate on oil sump sealing face.

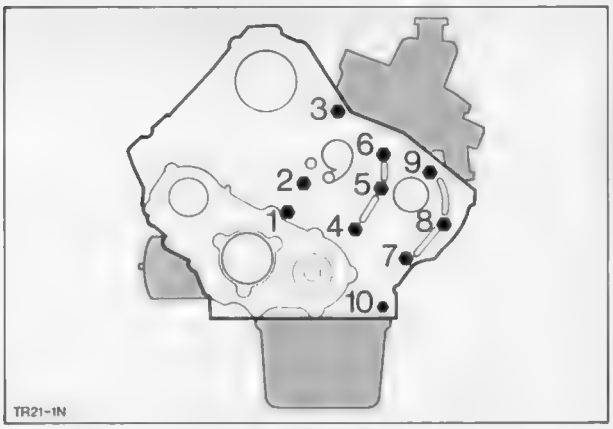


Fig. 75. Intermediate plate bolt tightening sequence

21 134 8 (cont'd)

51. Fit injection pump bracket to engine block.

52. Fit vacuum pump with bracket to intermediate plate.

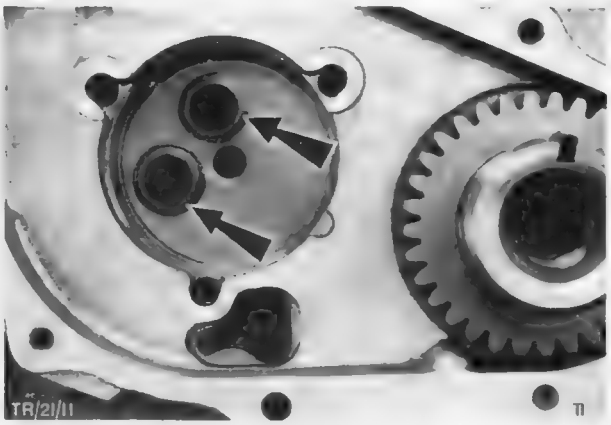


Fig. 76. Fit oil pump O-rings

53. Fit oil pump with new O-rings, Fig. 76 and secure, Fig. 77.

Before installing oil pump rotate by hand and fill with engine oil.

Oil pump bores are offset and pump can therefore be installed in one position only.

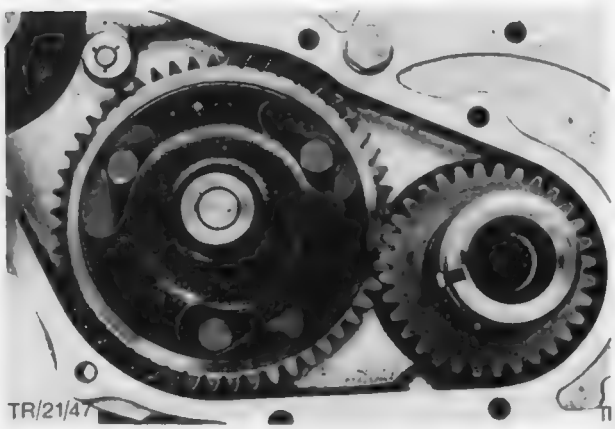


Fig. 77. Fit oil pump

54. Check oil pump gear backlash, Fig. 78, (see Technical Data) and fit new gears, if required.

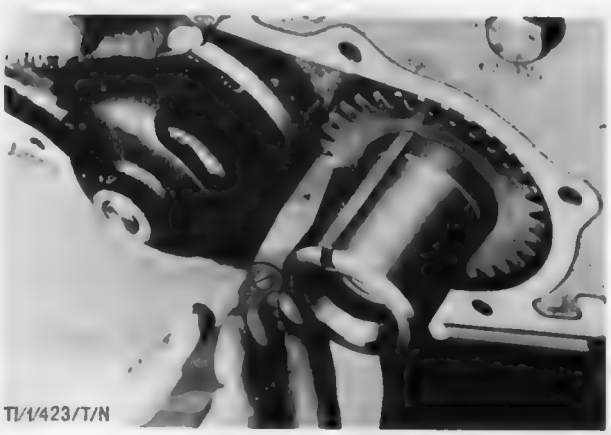


Fig. 78. Check oil pump gear backlash

55. Replace crankshaft front oil seal:
Drive oil seal out of timing cover using hammer and mandrel. Slightly oil sealing lip of new oil seal, carefully drive into timing cover, using Special Tool 21–025, Fig. 79, then fit timing cover and new gasket to intermediate plate. Centralise with same Special Tool, Fig. 80 and secure, fitting bolts coated with sealing compound.

Fig. 79. Fit crankshaft front oil seal to timing cover, using Special Tool 21–025

56. Fit vacuum pump pulley and hub.

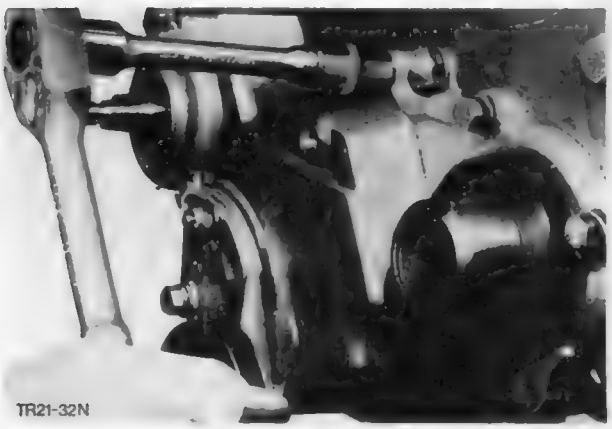


Fig. 80. Centralise timing cover using Special Tool 21–025

57. Fit water pump with new gasket to intermediate plate, Fig. 81.

Fig. 81. Fit water pump

21 134 8 (cont'd)

58. Apply oil to camshaft spacer mating surface, slide on to camshaft and coat front face with sealing compound.

59. Lock camshaft gear using Special Tool 21–016 and torque as specified in Technical Data, Fig. 82.

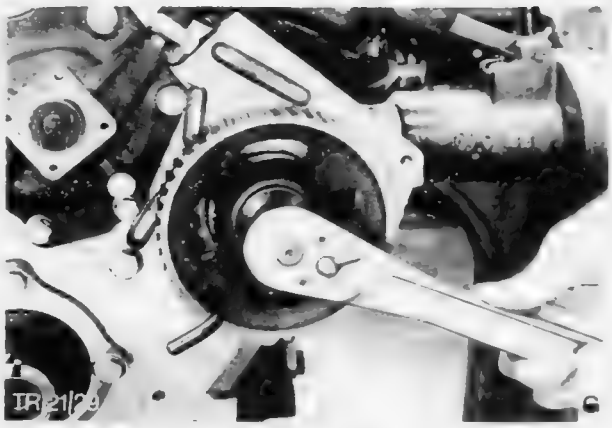


Fig. 82. Lock camshaft gear using Special Tool 21–016 and secure

60. Apply oil to crankshaft spacer mating surface, slide on to crankshaft and coat front face with sealing compound.

61. Fit toothed belt thrust washer and fit crankshaft journal, coating inside of bolt with sealing compound.

62. Fit crankshaft journal centre bolt hand-tight and using Special Tool 21–018/019 torque as specified in Technical Data, Fig. 83.

10 spindle turns = 150 Nm (15 kgf m) (108 lbf ft).

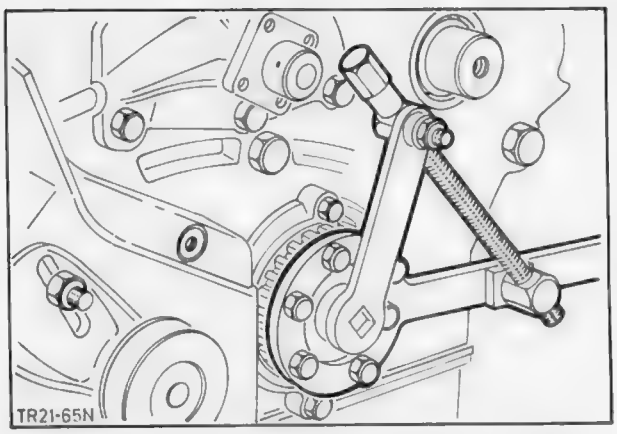


Fig. 83. Secure crankshaft journal bolt using Special Tool 21-018/019

63. Pre-load toothed belt tensioner and fit hand-tight. Align gears on marks, rotating crankshaft until crankshaft gear hub groove is aligned on timing cover mark. Check adjusting peg 21–016 is still correctly located in camshaft gear. Set injector adjuster to zero position. Rotate injection pump gear until setting specified in Technical Data is obtained. Then tighten injection pump gear nuts.

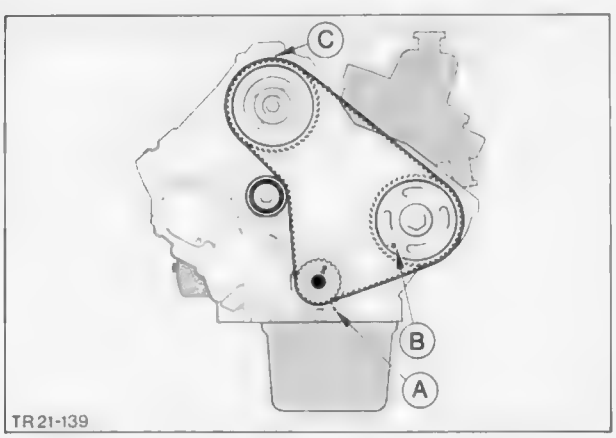


Fig. 84. Fuel injection pump marking

64. Position toothed belt, withdraw adjusting peg 21–016 from camshaft gear, rotate crankshaft through 2 revolutions, recheck markings, press toothed belt tensioner against belt and tighten, Fig. 85.

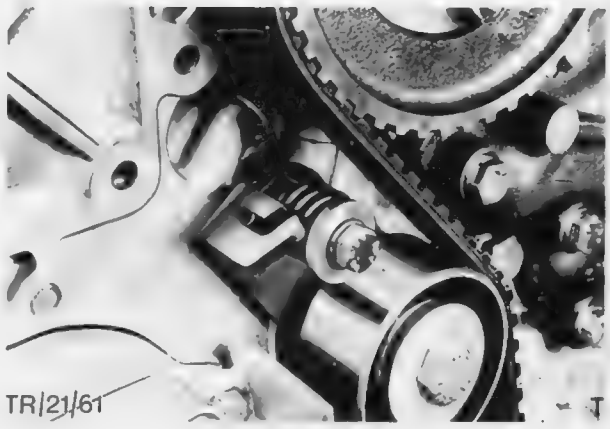


Fig. 85. Tighten belt tensioner

65. Position sump gasket, applying sealer to joints and gasket around joints, Fig. 86. Locate oil sump and torque bolts as specified in Technical Data.

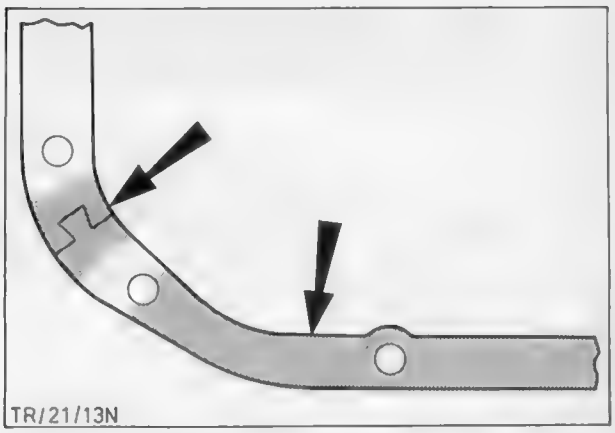


Fig. 86. Apply sealing compound to sump gasket

Fit two Allen screws each, front and rear, and secure, Fig. 87.

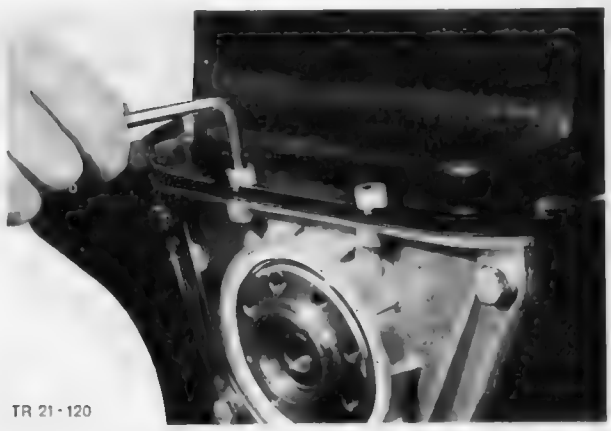


Fig. 87. Tighten front and rear sump bolts

21 134 8 (cont'd)

66. Fit back plate and flywheel, tighten bolts as specified in Technical Data and check for run-out, Fig. 88.

Flywheel bolt holes are offset and the flywheel can therefore be fitted in one position only.

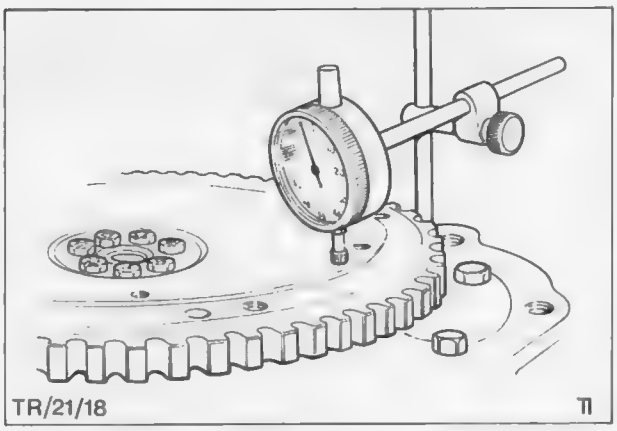


Fig. 88. Check flywheel run-out

67. Fit clutch pressure plate and centralise clutch disc, using Special Tool 21–044, Fig. 89 and torque bolts as specified in Technical Data.

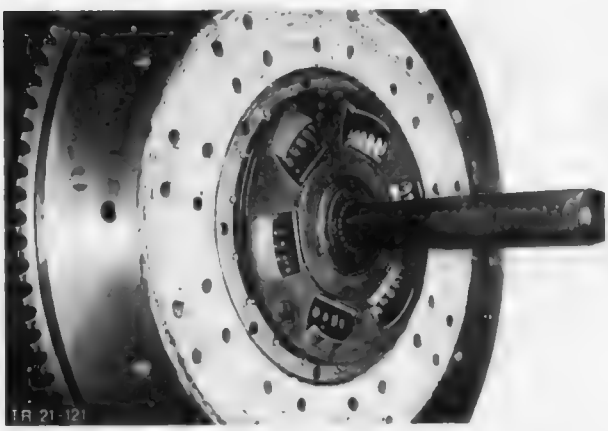


Fig. 89. Centralise clutch disc using Special Tool 21–044

68. Position cylinder head gasket with Part No. facing upwards and carefully locate cylinder head on guide sleeves, taking care to ensure correct assembly of by-pass hose. Fit cylinder head bolts in sequence shown in Fig. 90 and torque as specified in Technical Data.

Before replacing cylinder head check correct location of combustion chamber inserts.

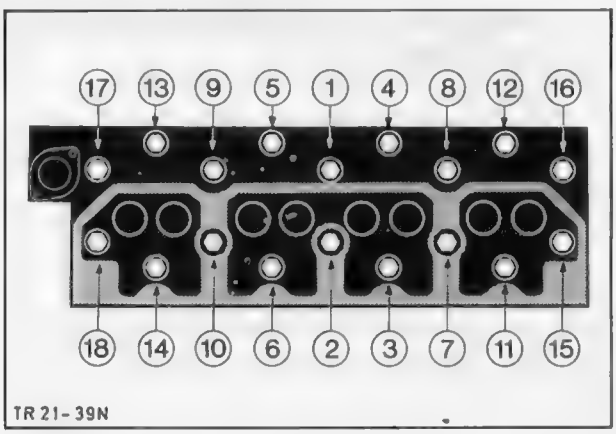


Fig. 90. Cylinder head bolt tightening sequence

69. Fit thermostat, Fig. 91, and install water neck with new gasket.

Fig. 91. Fit thermostat

70. Insert heat shields with new gaskets. Position new heat balancing plates, with convex side upwards, and new nozzle holder sealing rings, Fig. 92, and uniformly torque injector nozzles as specified in Technical Data.

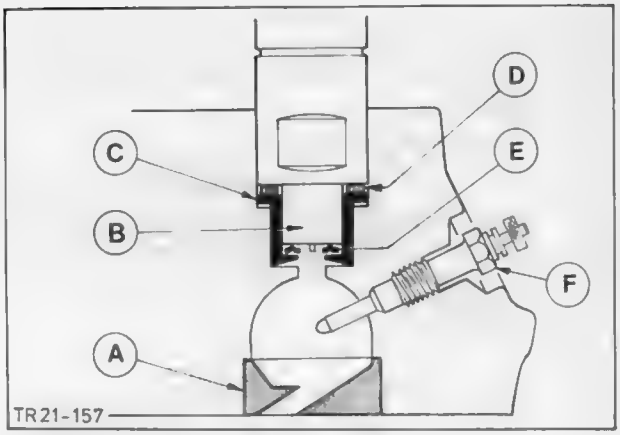


Fig. 92. Combustion chamber – cut-away view
A – Combustion chamber insert
B – Heat shield
C – Heat shield gasket
D – Nozzle holder gasket
E – Heat balancing plate

71. Lubricate push rods and guide them into the same sockets from which they were removed. Fit rocker shaft, inserting push rods into rocker arm sockets, Fig. 93. Tighten upper five rocker shaft bolts, followed by three lower bolts.

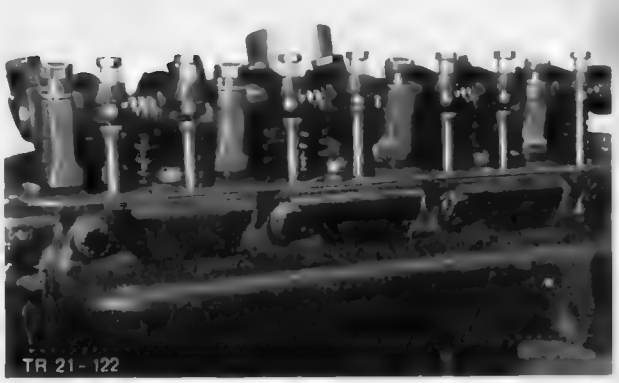


Fig. 93. Fit push rods in rocker arm sockets

21 134 8 (cont'd)

72. Adjust valve clearance Fig. 94 (see Operation 21–213), cranking engine **only** in direction of rotation.
73. Evenly tighten rocker cover bolts with new gasket. Fit oil filler cap and breather tube.
74. Fit upper and lower toothed belt cover.
75. Fit crankshaft pulley and fan with spacer. Install alternator complete with bracket.

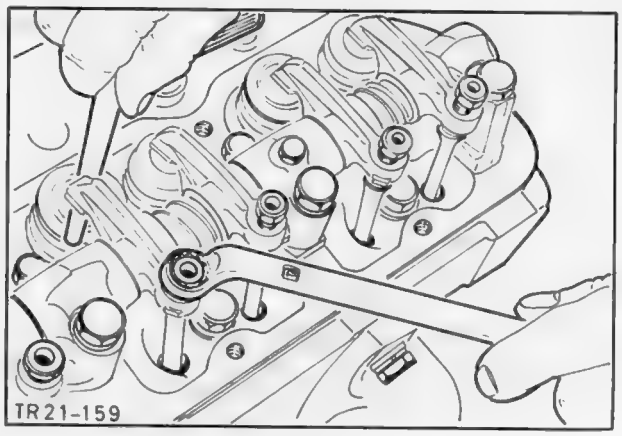


Fig. 94. Adjust valve clearance

76. Adjust alternator and vacuum belt tension to achieve 13 mm (0,5 in) free movement mid-way between alternator and pump pulleys. Fig. 95.
77. Fit fuel filter and bracket.
78. Connect vacuum pump feed pipe.
79. Connect injector lines and overflow pipe. Connect injection pump filter fuel lines.

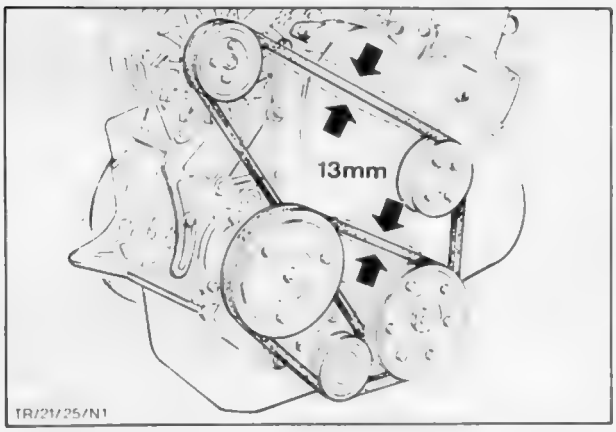


Fig. 95. Adjust alternator and vacuum pump V-belt tension

80. Using suitable hand syringe, fill not less than 1 litre (1,75 pints) engine oil through full-flow oil filter drilling into main oil gallery, then secure full-flow oil filter complete with new cartridge and gasket as specified in Technical Data, Fig. 96. Insert oil dipstick.
81. Remove engine from engine assembly stand and refit front left-hand engine mounting rubber insulator.

Fig. 96. Fit full-flow oil filter

21 154 SUMP – REMOVE AND INSTALL

Special Service Tools Required: None

To Remove

1. Jack up vehicle or drive over pit.
2. Drain engine oil.
3. Remove sump (24 bolts), removing rear Allen screws using standard tool, Fig. 97.

Fig. 97. Remove Allen screws

To Install

4. Clean engine block to sump sealing faces. Stick gasket to block using grease, applying sealer to joints and gasket in vicinity of joints, Fig. 98.

5. Carefully locate sump, fit screws (front and rear 2 Allen screws each) and evenly torque as specified in Technical Data.
6. Top up engine oil, start engine and check for leaks.
7. Lower vehicle or remove from pit, as applicable.

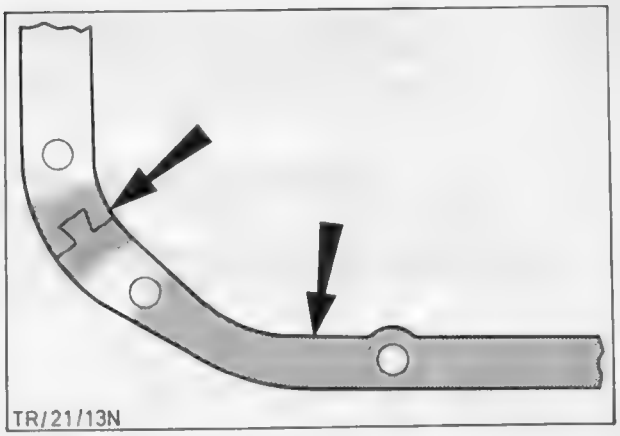


Fig. 98. Apply sealer to sump gasket

21 163 CYLINDER HEAD – REMOVE AND INSTALL

Special Service Tool Required:

Injector pipe nut wrench 21–041

To Remove

1. Remove earth strap from both batteries.
2. Drain coolant into tray, disconnecting lower radiator hose from water neck, Fig. 99 and top hose from thermostat water neck. Remove thermostat.

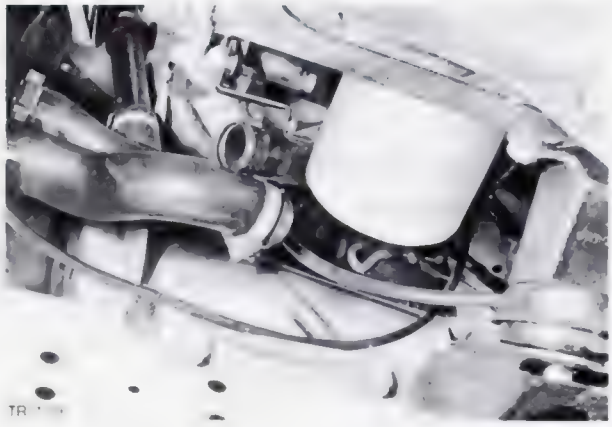


Fig. 99. Drain coolant

3. Remove air cleaner complete with bracket (2 bolts). Remove oil filler cap with breather hose.
4. Remove coolant expansion tank complete with bracket from cylinder head (3 bolts), Fig. 100.

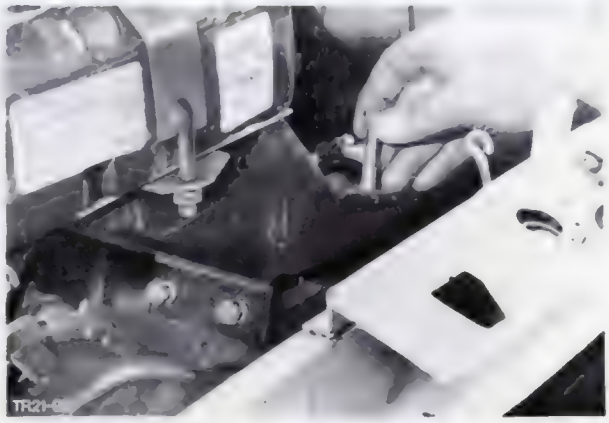


Fig. 100. Remove coolant expansion tank

5. Disconnect temperature sender unit and two glow plug leads from inlet manifold.
6. Remove overflow pipe from nozzles. Disconnect thermostart reservoir fuel lines from filter and inlet manifold.
7. Remove injector pipes, using Special Tool 21–041, Fig. 101.

   Place caps on nozzle and pump pipe connectors to protect from dirt.

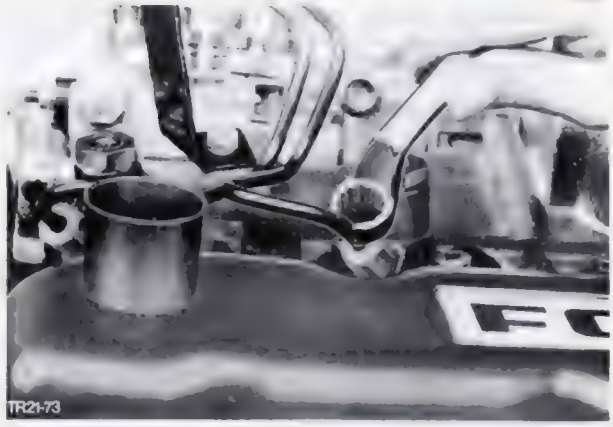


Fig. 101. Remove injector pipes using Special Tool 21–041

8. Remove fuel filter bracket from inlet manifold (1 bolt).
9. Disconnect water outlet connector (Fig. 102).
10. Disconnect heater hose at cylinder head front.
11. Remove exhaust pipe from manifold (2 nuts).
12. Remove rocker cover (6 bolts). Remove three lower then five upper rocker support bracket bolts. Remove rocker shaft and push rods.

    Do not interchange push rods when removing and installing.
13. Remove injector nozzles (2 bolts each).

Fig. 102. Remove water outlet connector

14. Remove engine mounting rubber insulators front right and left-hand side (2 nuts) and carefully raise engine from underneath sump to gain access for removal of toothed belt cover to cylinder head bolt and of water pump to cylinder head by-pass hose, Fig. 103.

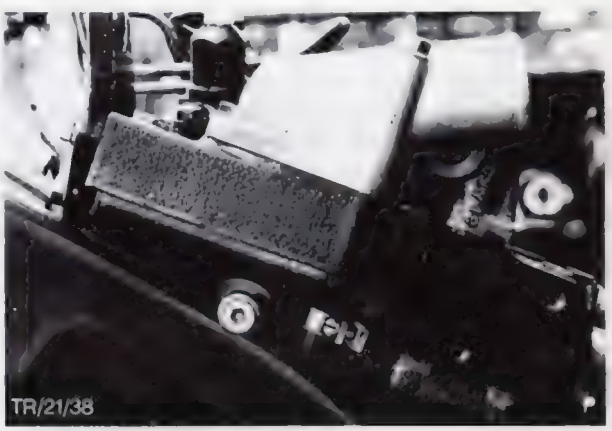


Fig. 103. Remove by-pass hose

15. Remove cylinder head bolts (18), reversing tightening sequence (for tightening sequence see Fig. 104). Lift out cylinder head complete with inlet and exhaust manifolds.

To Install

16. Clean cylinder head and engine block joint faces. Position new cylinder head gasket with part number facing upwards and carefully place cylinder head on locating bushes, ensuring correct assembly of by-pass hose. Tighten cylinder head bolts in sequence shown in Fig. 104 and torque as specified in Technical Data. Secure by-pass hose.

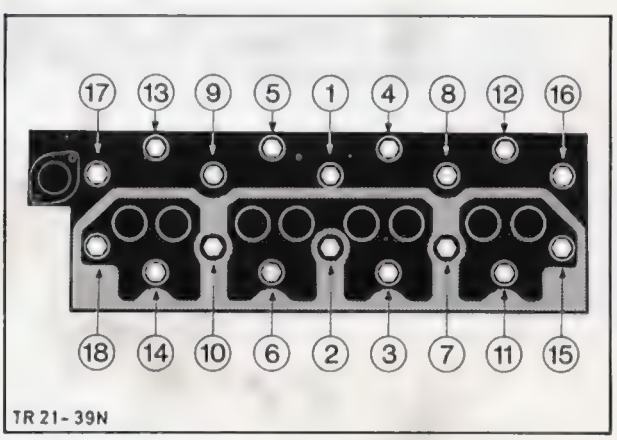


Fig. 104. Cylinder head bolt tightening sequence

21 163 (cont'd)

17. Insert toothed belt cover bolt in cylinder head.
18. Lower engine and fit right-hand and left-hand engine mounting rubber insulators, Fig. 105.

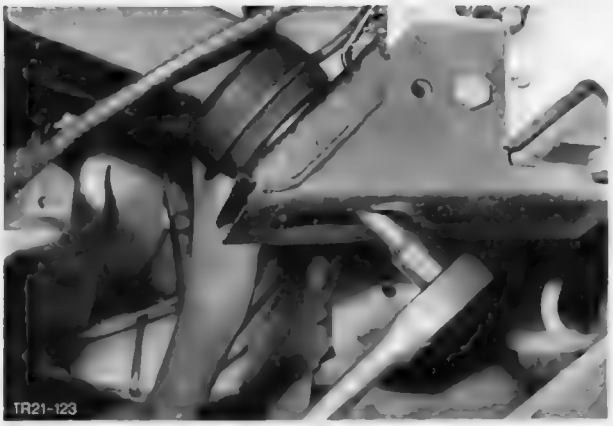


Fig. 105. Fit engine mounting rubber insulators

19. Carefully replace injector nozzles and tighten evenly.
20. Lubricate push rods and insert in same sequence as on removal. Fit rocker shaft, locating push rods in rocker arm sockets, Fig. 106. Tighten five upper, then three lower bracket bolts.

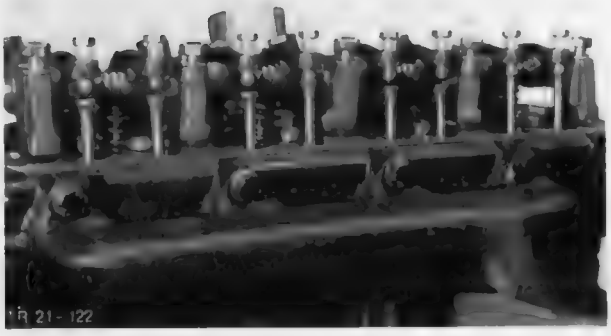


Fig. 106. Insert push rods in rocker arm sockets

21. Adjust valve clearances, Fig. 107, (see Operation 21 213), cranking engine **only** in direction of normal rotation.

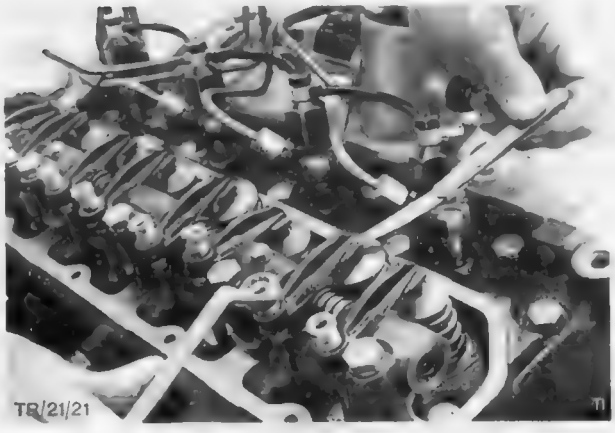


Fig. 107. Adjust valve clearances

22. Uniformly tighten rocker cover with new gasket.
23. Fit exhaust pipe to manifold.
24. Assemble heater hose to cylinder head, Fig. 108.

Fig. 108. Fit heater hose

25. Fit water outlet connector, Fig. 109.
26. Fit fuel filter bracket to inlet manifold.
27. Connect injector pipes and tighten as specified in Technical Data, using Special Tool 21–041.
28 Reconnect thermostart reservoir fuel lines to filter and inlet manifold and overflow oil line to nozzles.
29 Connect temperature sender unit and glow plug leads (2).
30. Fit coolant expansion tank with bracket to cylinder head.

Fig. 109. Fit water outlet connector

31. Refit oil filler cap and breather hose. Fit air cleaner complete with bracket, Fig. 110.
32. Slide lower and upper radiator hoses into position, tighten and top up coolant.
33. Reconnect both batteries.
34. Start engine and check for leaks.

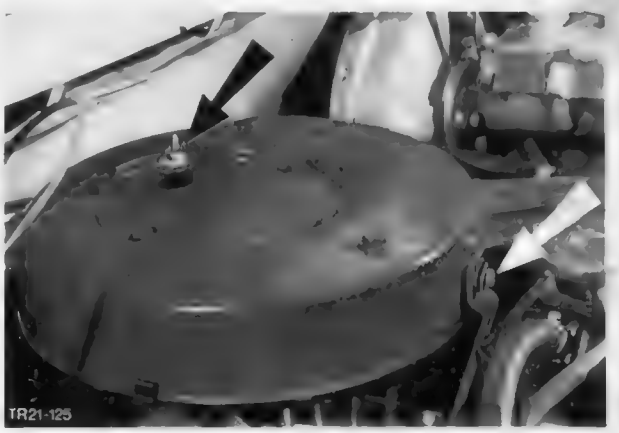


Fig. 110. Fit air cleaner

21 213 VALVE CLEARANCE – ADJUST

Special Service Tools Required: None

1. Remove water outlet connector, Fig. 111 and remove rocker cover (6 bolts).

Fig. 111. Remove water outlet connector

2. Adjust valve clearances as follows:

   Rotate crankshaft pulley clockwise until valve No. 1 cylinder is fully open, then adjust valve No. 4 (inlet) and No. 7 (exhaust). Continue rotating crankshaft pulley and adjust all valve clearances as set out below, Fig. 112.

Valve open	Adjust valve
No. 1	No. 4 (inlet) and 7 (exhaust)
No. 2	No. 5 (exhaust) and 8 (inlet)
No. 4	No. 1 (exhaust) and 6 (inlet)
No. 5	No. 2 (inlet) and 3 (exhaust)

3. Fit rocker cover with new gasket and tighten. Fit water outlet connector.

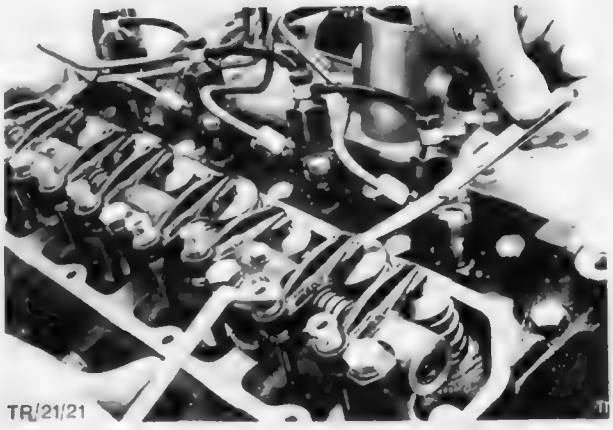


Fig. 112. Adjust valve clearances

21 217 4 VALVES – REMOVE AND INSTALL (cylinder head removed)

Special Service Tools Required: None

To Remove

1. Remove inlet and exhaust manifolds from cylinder head (8 bolts each) Fig. 113.
2. Remove caps from valve retainers and valve stems by tapping with plastic mallet.

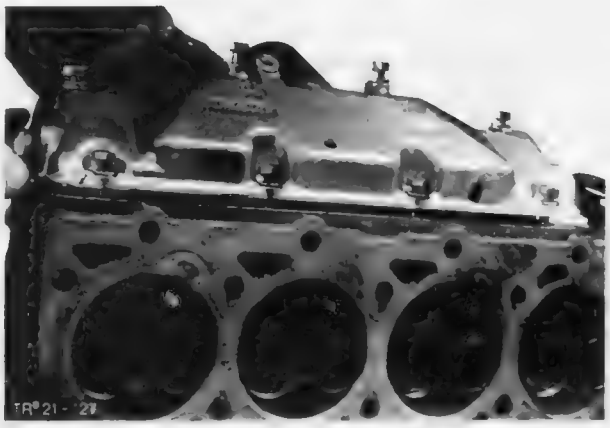


Fig. 113. Remove inlet manifold

3. Compress valve spring(s) using standard valve spring compressor, Fig. 114. Remove collets, release pressure on spring(s) and remove spring(s) and spring retainer. Withdraw valve stem seal and remove valve. Fit valve spring compressor to next valve and similarly remove remaining valves.

   When removing and refitting valve springs it is essential to ensure that valve stem is not damaged by valve spring when it is pressed down to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result would be excessive oil consumption and valve guide wear.

Fig. 114. Compress valve spring using standard compressor

To Install

4. Remove carbon and other deposits from valves and cylinder head galleries, then grind in valves, Fig. 115 and remove all traces of grinding paste from cylinder head.

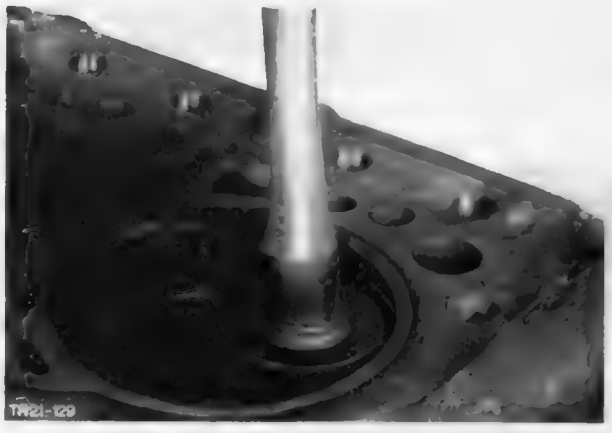


Fig. 115. Grind in valve

5. Lubricate and insert valves. Cover splines with adhesive foil, Fig. 116. Slide valve stem seals into position against stop, Fig. 117 and remove adhesive foil. Replace valve springs and valve spring retainers, compress with spring compressor and refit collets, paying attention to correct collet seating.

   Exhaust valves have 2 valve springs, Fig. 118.

   Every time valves are removed and installed new valve stem seals should be used. Cover valve splines with adhesive foil to prevent damage to valve stem seals.

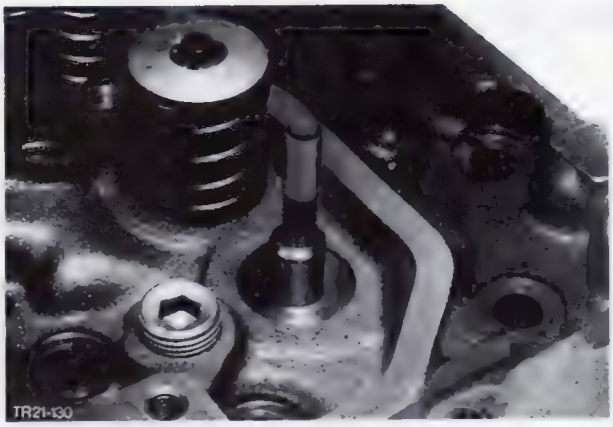


Fig. 116. Cover valve splines with adhesive foil

6. Release pressure on valve spring(s) and remove spring compressor.

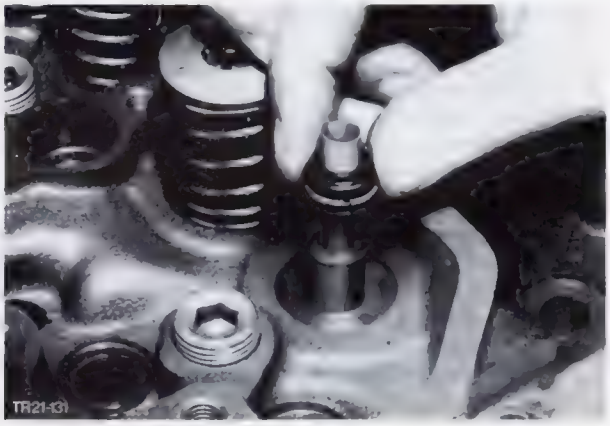


Fig. 117. Fit valve stem seals

7. Fit inlet and exhaust manifold and tighten bolts as specified in Technical Data.

Fig. 118. Exhaust valve – exploded view

21 231 9 VALVE SEAT – RECUT

Special Service Tools Required: None

Valve seat cutting will serve a useful purpose only if valve guide bores are not damaged. Prior to cutting therefore check valve stem clearance in guide and if necessary replace valve guide.

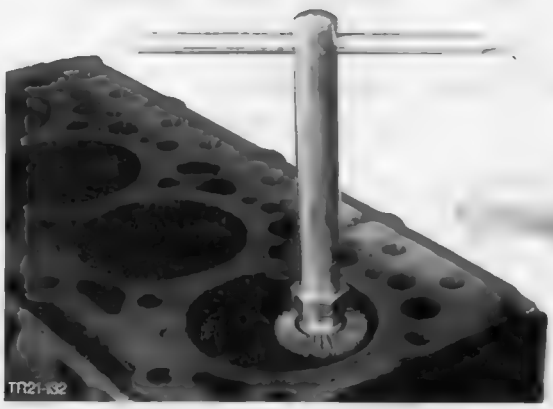


Fig. 119. Cut valve seat

1. Machine valve seat using standard valve seat milling cutters, Fig. 119, then re-machine valve seat width using correcting cutter and measure valve head depth in cylinder head, Fig. 120.

   When machining valve seat pay attention to differing valve seat angles in cylinder head, Fig. 121 (see Technical Data).

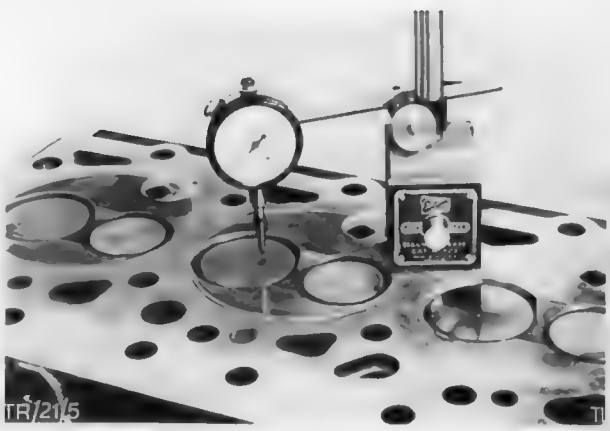


Fig. 120. Valve head depth in cylinder head

2. Remove swarf from cylinder head and valves.

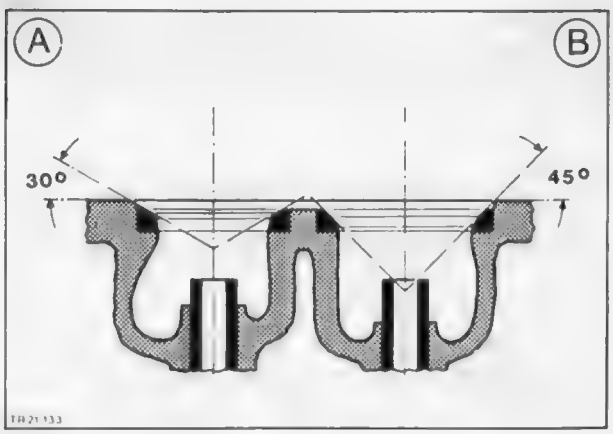


Fig. 121. Valve seat angle
A – Exhaust valve
B – Inlet valve

21 235 4 VALVE GUIDE – REPLACE (valves removed)

Special Service Tool Required:

Valve guide remover and installer . . 21–021

To Remove

1. Using Special Tool 21–021 press valve guide out of cylinder head from below, Fig. 122.

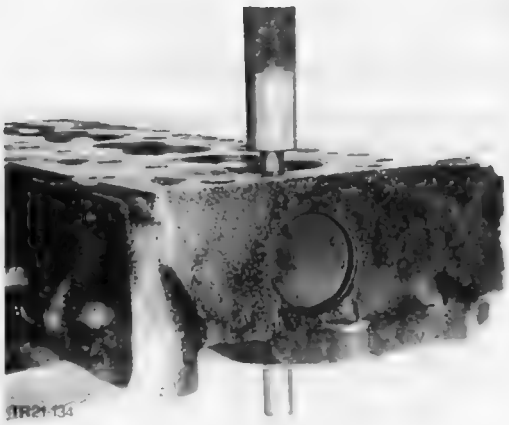


Fig. 122. Remove valve guide

To Install

2. Using the same tool press in valve guide from top in cylinder head up to mark, Fig. 123.

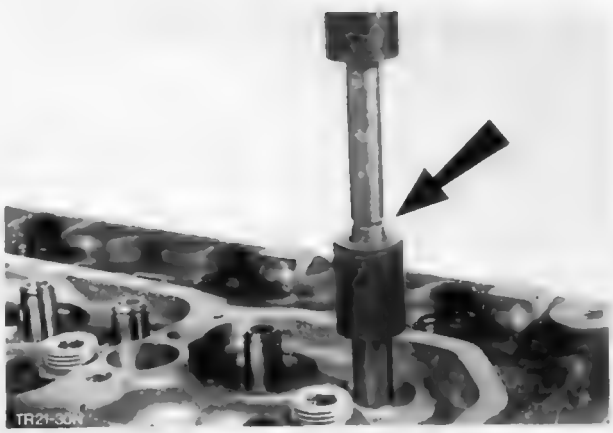


Fig. 123. Fit valve guide

21 255 9 ROCKER SHAFT ASSEMBLY – OVERHAUL (rocker shaft removed)

Special Service Tools Required: None

To Dismantle

1. Remove outer rocker supports (2) and outer rocker arms (4) with springs (2) from rocker shaft.
2. Remove inner rocker supports (2) from shaft (2 bolts), then remove inner rocker arms (4) with springs (2), and centre support.

To Reassemble

3. Assemble rocker shaft as shown in Fig. 124, having previously lubricated rocker shaft and rocker arm sliding faces.

   With rocker shaft fitted oil bores for rocker shaft lubrication must point upwards.

   On new rocker shafts check plugs in both shaft ends.

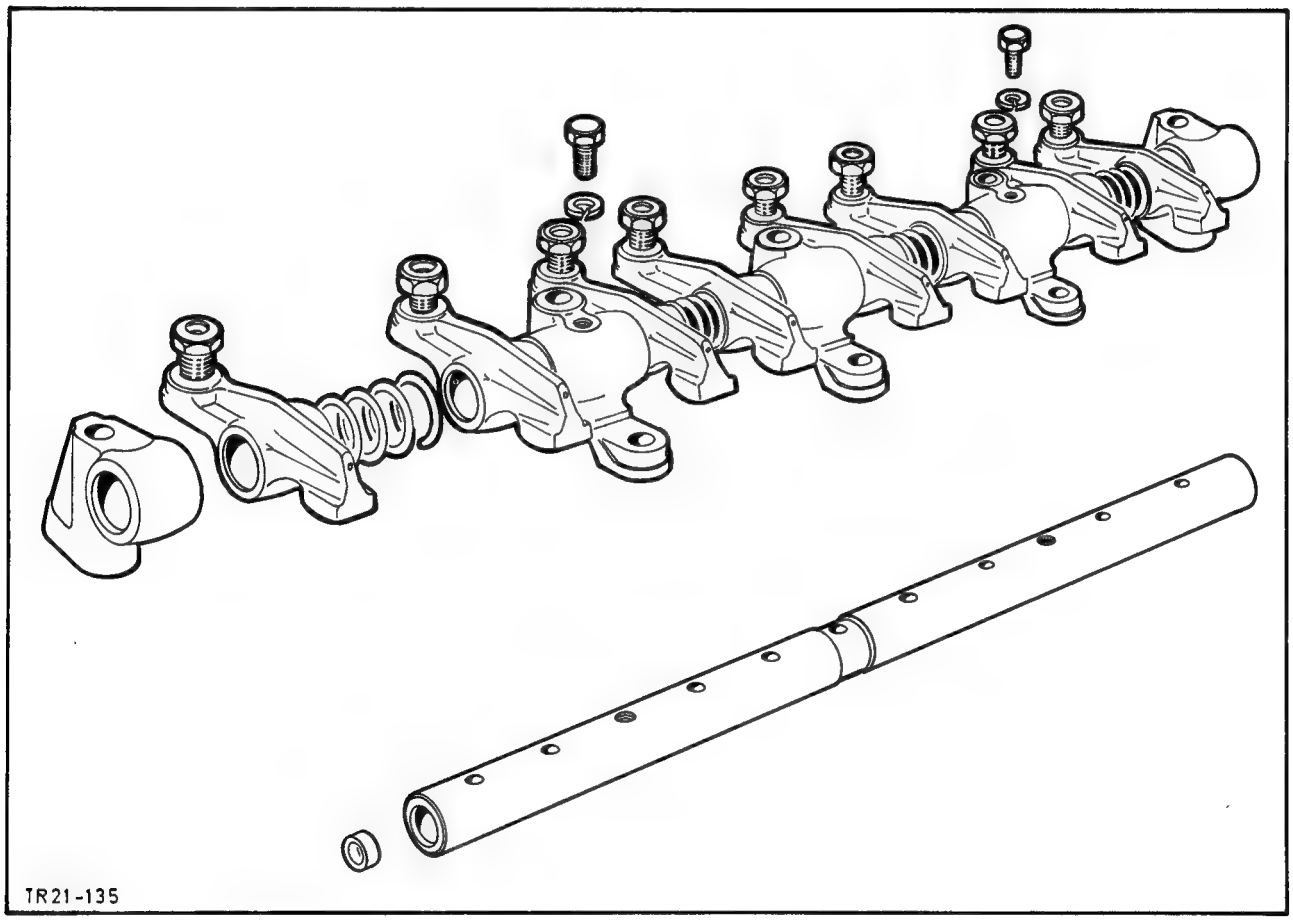


Fig. 124. Rocker shaft assembly dismantled

21 286 6 CAMSHAFT BEARINGS – REPLACE (engine dismantled)

Special Service Tools Required:

Camshaft bearing remover/replacer .. 21–022
Adaptors .. 21–022–01 and 21–022–02

1. From front of engine remove bushes Nos. 5, 4, 3 and 2 using Special Tool 21–022 and associated adaptors 21–022–01 and 21–022–02, Fig. 125.

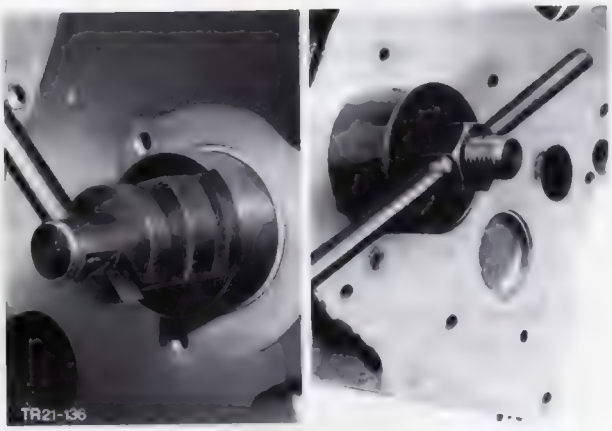


Fig. 125. Withdraw bearing bush No. 5 from front using Special Tool 21–022–01/02

2. Back off main tool spindle and fit new bearing bushes Nos. 5, 4, 3 and 2, using same Special Tool, Fig. 126.

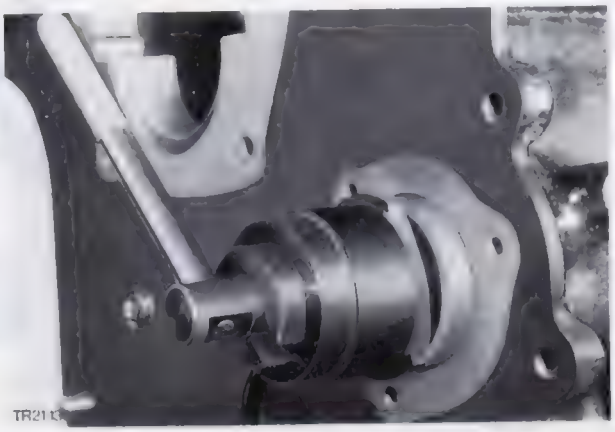


Fig. 126. Back off spindle and fit new bearing bush No. 5

3. Replace bearing bush No. 1, paying attention to lug being aligned on bush bore, then secure bush, Fig. 127.

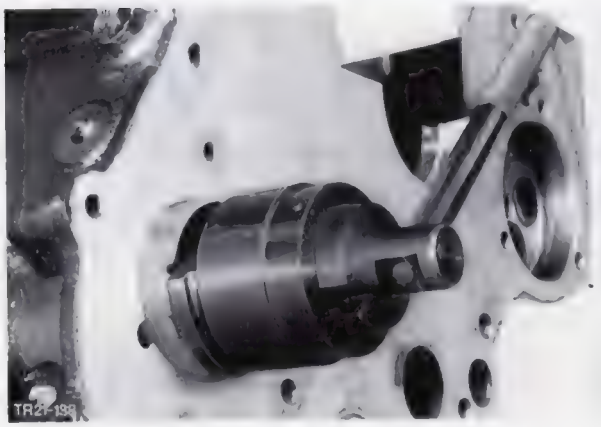


Fig. 127. Replace bearing bush No. 1

21 288 CAMSHAFT OIL SEAL – REPLACE

Special Service Tools Required:

Camshaft oil seal remover ..	.. 15–048
Remover adaptor	15–048–01
Camshaft gear timing peg ..	.. 21–016
Camshaft oil seal replacer ..	.. 21–017

To Remove

1. Remove earth strap from both batteries.
2. Drain coolant into trays, removing lower radiator hose from water pipe, Fig. 128 and upper hose from thermostat water neck.

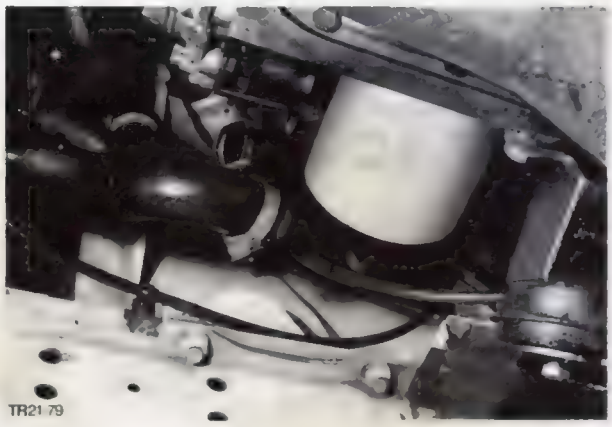


Fig. 128. Drain coolant

3. Remove radiator hose and expansion tank by-pass hose from radiator.
4. Remove radiator (4 bolts) and lift out.
5. Slacken vacuum pump V-belt tensioner (1 bolt and 1 nut), Fig. 129 and alternator bracket (4 bolts) and remove both V-belts.

Fig. 129. Slacken vacuum pump V-belt tensioner

6. Remove fan with pulley (4 bolts).
7. Remove toothed belt cover (5 bolts).
8. Rotate engine until crankshaft, camshaft and injection pump gear markings are aligned on timing cover mark, Fig. 130.

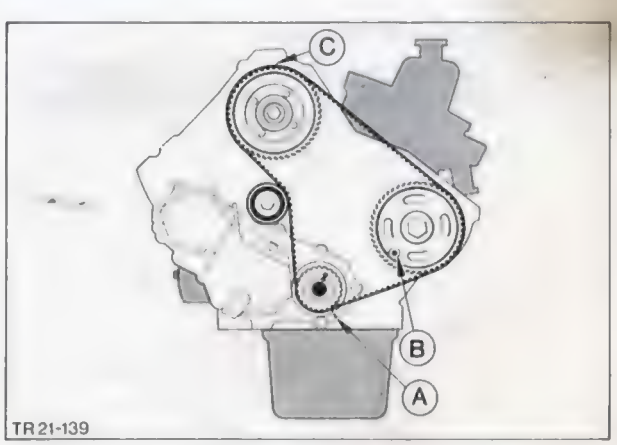


Fig. 130. Toothed belt pulley markings
A – Crankshaft
B – Camshaft
C – Fuel injection pump

21 288 (cont'd)

9. Slacken toothed belt tensioner, Fig. 131, reduce tension using screwdriver and remove toothed belt.

   Do not crank engine after toothed belt removal as this would cause damage to pistons and valves.

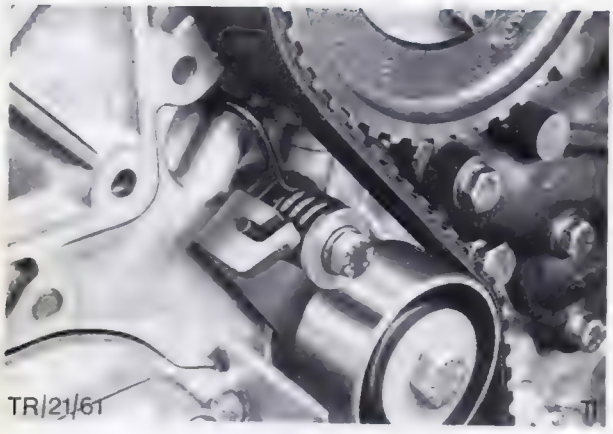


Fig. 131. Slacken toothed belt tensioner

10. Lock camshaft gear using Special Tool 21–016, Fig. 132, remove bolt and press off gear by means of two levers.

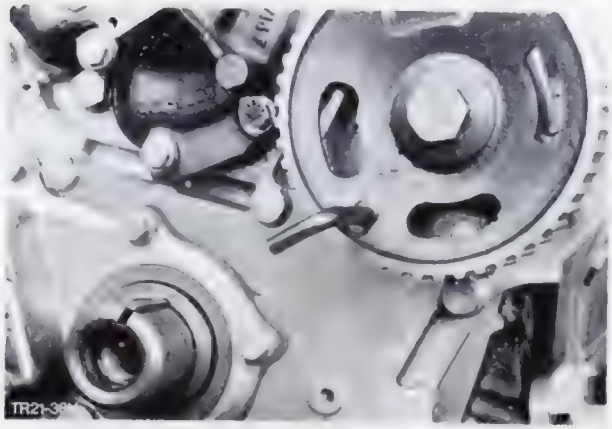


Fig. 132. Lock camshaft gear using Special Tool 21–016

11. Remove camshaft spacer.
12. Remove camshaft oil seal using Special Tool 15–048 and adaptor 15–048–01, Fig. 133.

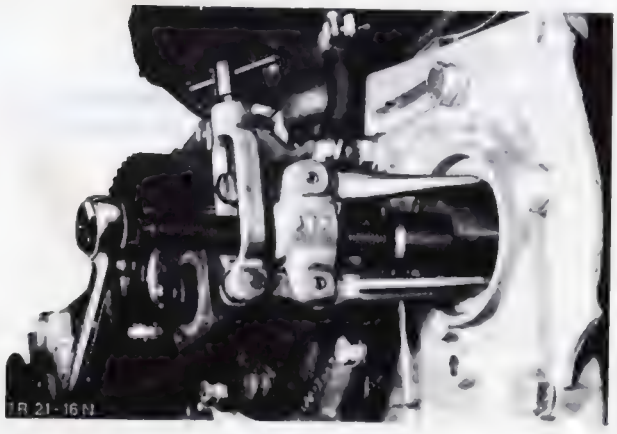


Fig. 133. Remove camshaft oil seal using Special Tool 15–048/048–01

To Install

13. Lubricate camshaft oil seal lip and using Special Tool 21–017 with bolt carefully press fully home, Fig. 134 ensuring camshaft alignment is not disturbed. Then again remove bolt.
14. Lubricate spacer rear surface, slide spacer on to camshaft and apply sealer to front.
15. Fit camshaft gear, lock with Special Tool 21–016 and torque as specified in Technical Data, applying sealer to bolt head inside. Remove timing peg.

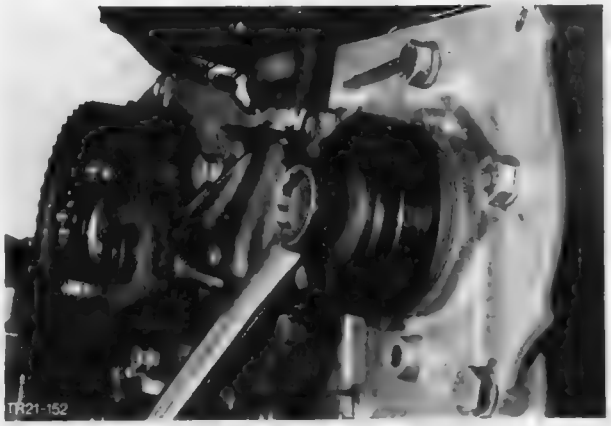


Fig. 134. Fit camshaft oil seal using Special Tool 21–017

16. Check crankshaft, camshaft and injection pump markings. Slacken toothed belt tensioner and position toothed belt, Fig. 135.
17. Press tensioner against toothed belt, crank engine twice in direction of rotation and secure tensioner.
18. Fit toothed belt cover.
19. Fit fan and pulley.

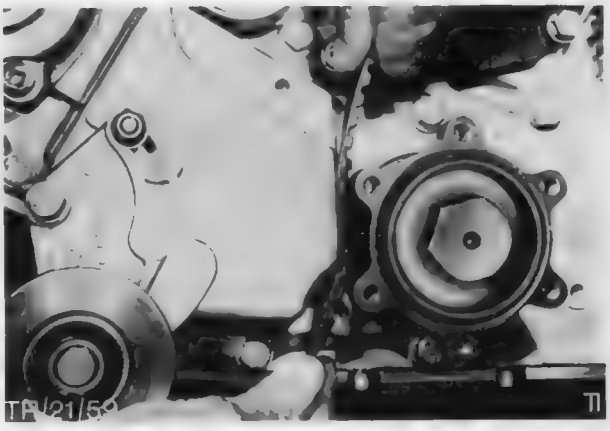


Fig. 135. Position toothed belt

20. Position alternator and vacuum pump V-belts and adjust tension in such a manner that free play at a point midway between pulleys is 13 mm (0,5 in), Fig. 136.
21. Insert and secure radiator. Fit and tighten expansion tank radiator hoses as well as upper and lower radiator hoses.
22. Top up coolant and check engine oil level.
23. Connect earth strap on both batteries, start engine and check for leaks.

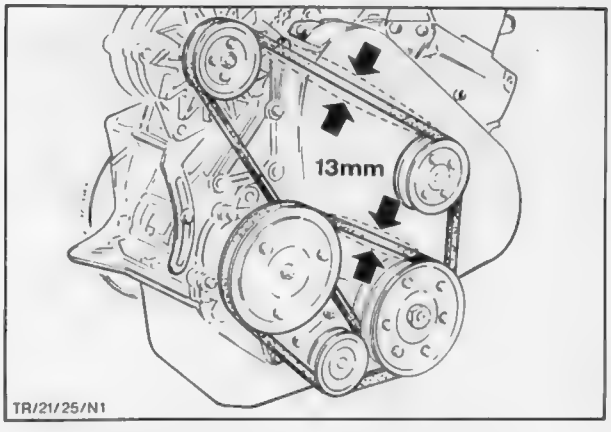


Fig. 136. Adjust alternator and vacuum V-belt tension

21 304 TIMING BELT – REPLACE

Special Service Tools Required: None

With the exception of crankshaft pulley removal this operation is contained in **Operation 21 288 – Camshaft oil seal – replace** and should be carried out as follows:

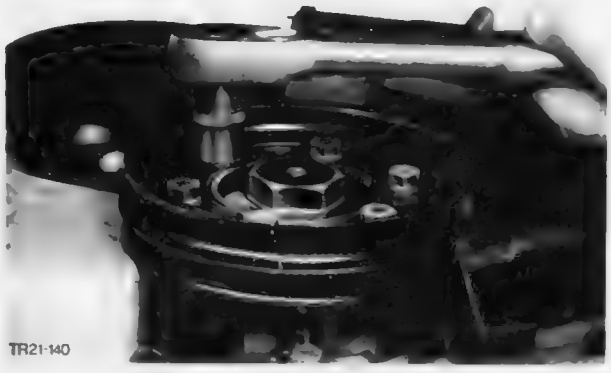


Fig. 137. Remove crankshaft pulley

To Remove

1. Carry out sub-operations 1–6 as described in Operation 21 288.
2. Remove crankshaft pulley (6 bolts) Fig. 137.
3. Carry out sub-operations 7–9 as described in Operation 21 288.

To Install

4. Carry out sub-operations 16–18 as described in Operation 21 288.
5. Fit crankshaft pulley, Fig. 138 and secure as specified in Technical Data.
6. Carry out sub-operations 19–23 as described in Operation 21 288.

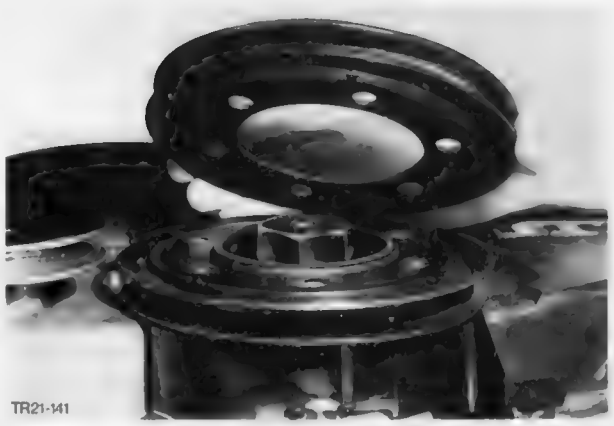


Fig. 138. Fit crankshaft pulley

21 467 SEAL – CRANKSHAFT FRONT – REPLACE

Special Service Tools Required:

Camshaft gear timing peg 21–016
Crankshaft flange holding wrench .. 21–018
Crankshaft flange bolt remover/replacer 21–019
Crankshaft front oil seal aligner 21–025

To Remove

1. Remove earth strap from both batteries.
2. Drain coolant into tray, slackening and removing lower radiator hose from water pipe, Fig. 139 and upper hose from thermostat water neck.

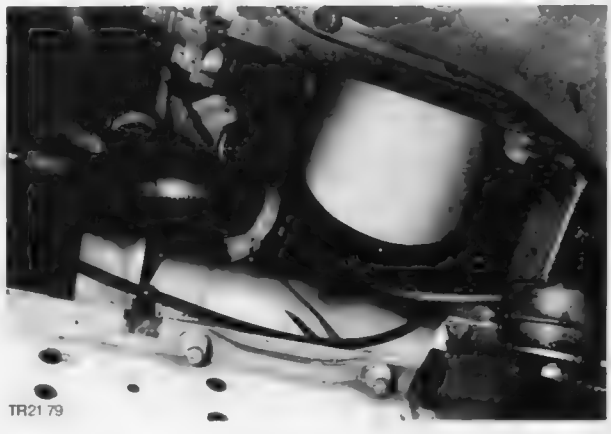


Fig. 139. Drain coolant

3. Remove radiator hose and expansion tank bypass hose from radiator.
4. Remove radiator at bottom location (2 bolts) from crossmember mountings, Fig. 140.

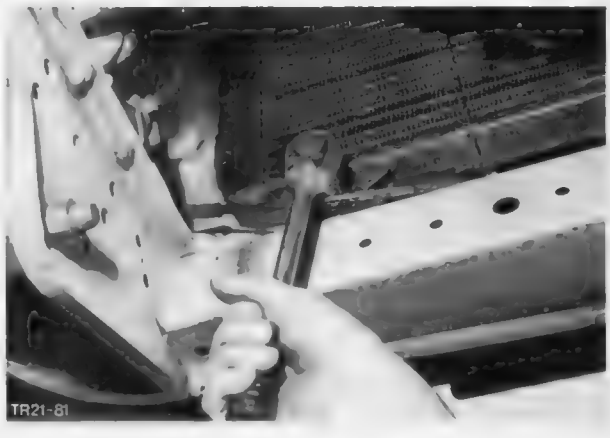


Fig. 140. Unscrew radiator at bottom location

5. Unhook hood cable at catch, Fig. 141 and unscrew from radiator grille panel.

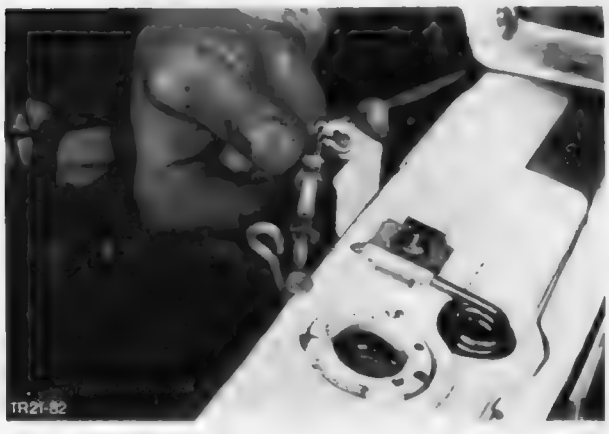


Fig. 141. Unhook hood cable

21 467 (cont'd)

6. Remove right-hand and left-hand headlamp surround (1 bolt each).
7. Remove radiator grille panel complete with radiator (11 bolts).
8. Slacken vacuum pump (1 bolt, 1 nut) and alternator bracket tensioner (4 bolts) and remove both V-belts, Fig. 142.

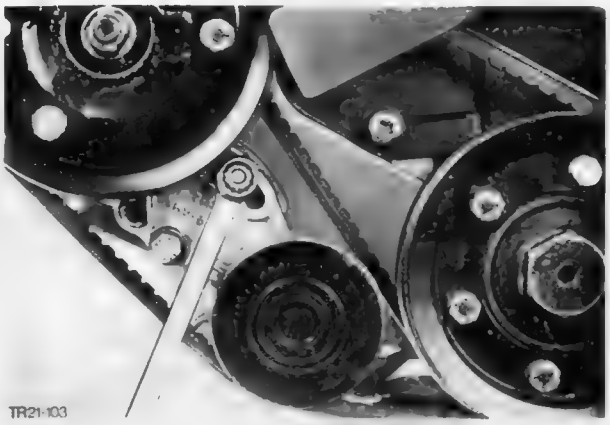


Fig. 142. Slacken vacuum pump V-belt tensioner

9. Remove fan and pulley (4 bolts).
10. Remove crankshaft pulley (6 bolts), Fig. 143.
11. Remove upper (5) and lower (2) toothed belt cover bolts and remove covers.

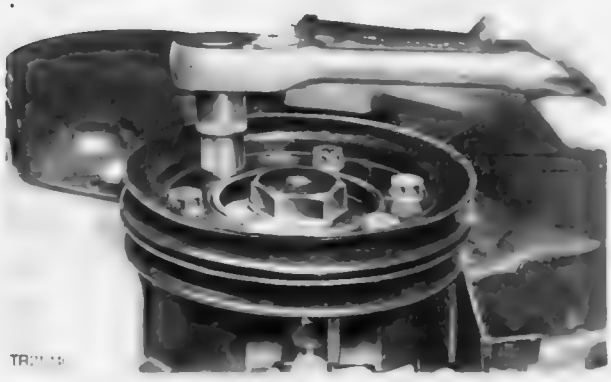


Fig. 143. Remove crankshaft pulley

12. Crank engine until crankshaft gear mark is aligned on timing cover mark, Fig. 144.

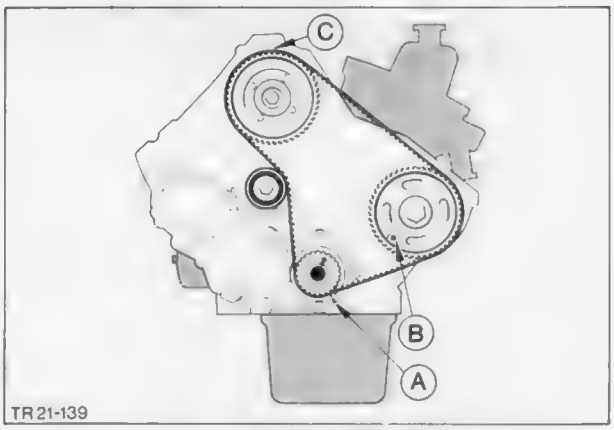


Fig. 144. Toothed belt pulley markings
A – Crankshaft
B – Camshaft
C – Fuel injection pump

13. Slacken toothed belt tensioner, Fig. 145 using screwdriver and remove toothed belt.

Do not crank engine after toothed belt removal as this will cause damage to pistons and valves.

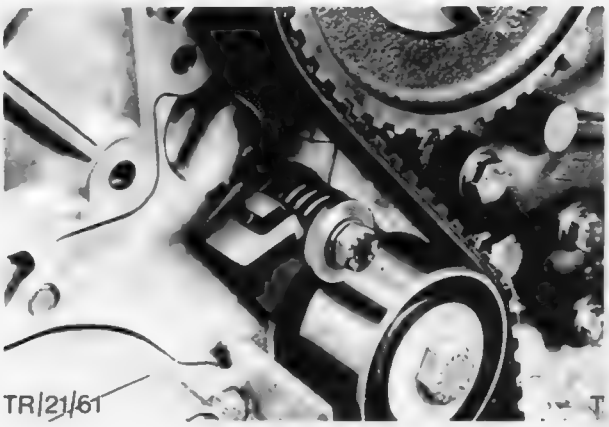


Fig. 145. Slacken toothed belt tensioner

14. Slacken crankshaft hub centre bolt using Special Tool 21–018/19, Fig. 146 and remove bolt.
15. Remove crankshaft hub using standard remover and remove toothed belt thrust washer.
16. Remove vacuum pump pulley (3 bolts).

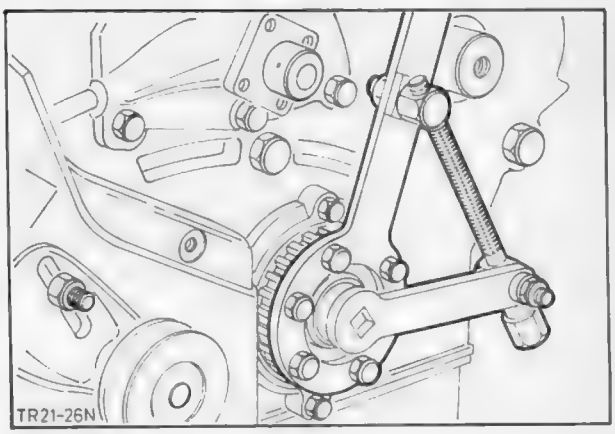


Fig. 146. Slacken crankshaft hub centre bolt using Special Tool 21–018/019

17. Remove vacuum pump hub (1 nut) using standard remover, Fig. 147.
18. Remove timing cover from intermediate plate (10 bolts).
19. Press off crankshaft spacer and remove.
20. Using hammer and mandrel, drive crankshaft oil seal to rear out of timing cover.

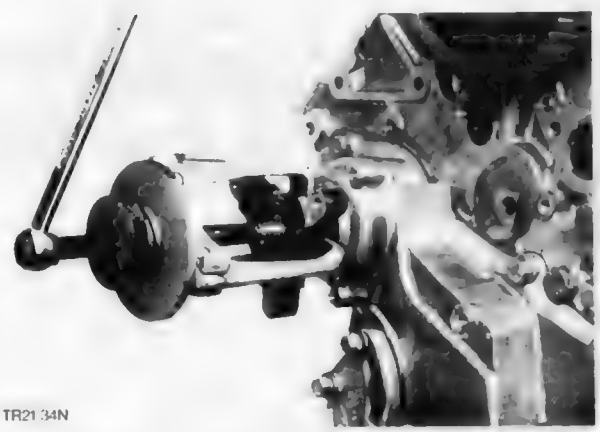


Fig. 147. Remove vacuum pump hub

21 467 (cont'd)

To Install

21. Lubricate crankshaft oil seal lip and insert oil seal into timing cover from rear up to stop, using Special Tool 21–025, Fig. 148.

Fig. 148. Fit crankshaft oil seal using Special Tool 21–025

22. Fit timing cover with new gasket to intermediate plate, centralise and secure with same Special Tool, Fig. 149, applying sealer to bolts.

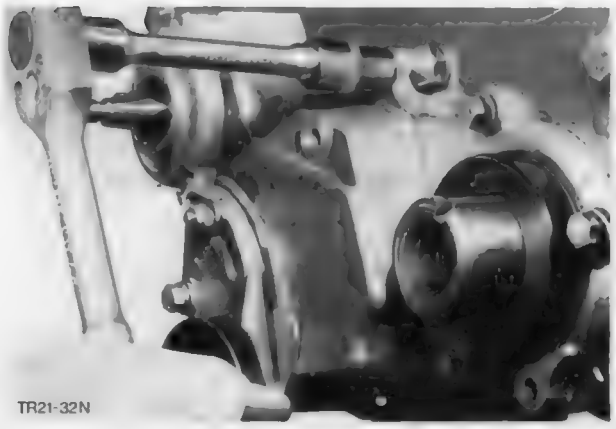


Fig. 149. Centralise timing cover using Special Tool 21–025

23. Fit vacuum pump hub and secure pulley.
24. Lubricate crankshaft spacer rear face, slide on to crankshaft and coat front with sealer.
25. Slide toothed belt thrust washer into position and fit crankshaft hub, Fig. 150, applying sealer to bolt head inside.

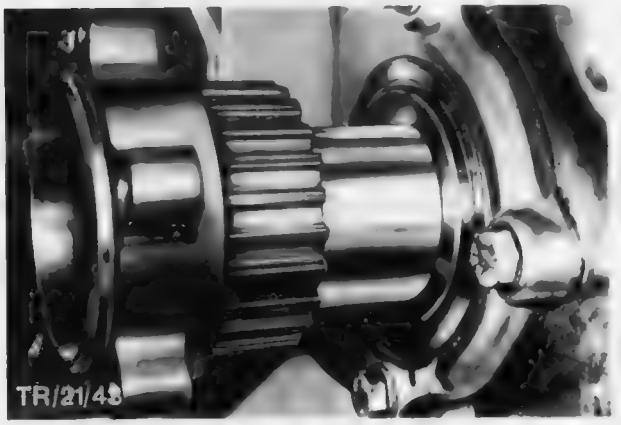


Fig. 150. Fit crankshaft hub

26. Fit crankshaft hub centre bolt hand-tight and torque as specified in Technical Data using Special Tool 21–018/019, Fig. 151.

10 spindle turns = 150 Nm (15 kgf m) (108 lbf ft).

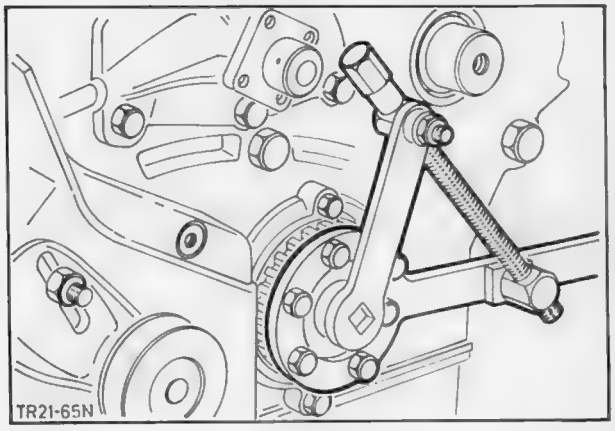


Fig. 151. Fit crankshaft hub centre bolt using Special Tool 21–018/019

27. Check markings on crankshaft, camsnaft and injection pump, Fig. 152, using timing peg 21–016.

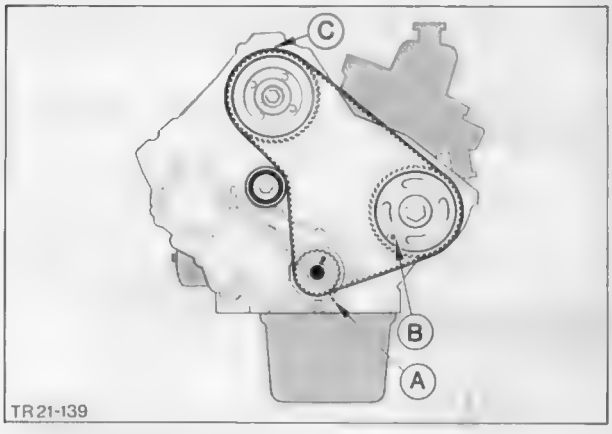


Fig. 152. Toothed belt pulley markings
A – Crankshaft
B – Camshaft
C – Fuel injection pump

28. Slacken toothed belt tensioner and position toothed belt, Fig. 153.

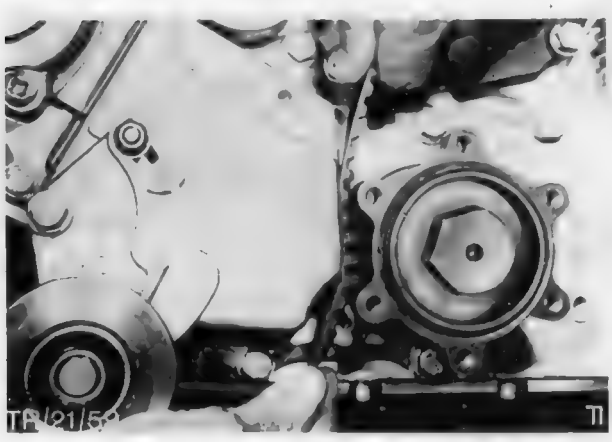


Fig. 153. Position toothed belt

29. Press tensioner against toothed belt, crank engine twice in direction of normal rotation and tighten tensioner.
30. Fit upper and lower toothed belt covers.
31. Fit crankshaft pulley as well as fan with pulley.
32. Position alternator and vacuum pump V-belts and adjust tension to achieve free movement of 13 mm (0,5 in) midway between pulleys, Fig. 154.

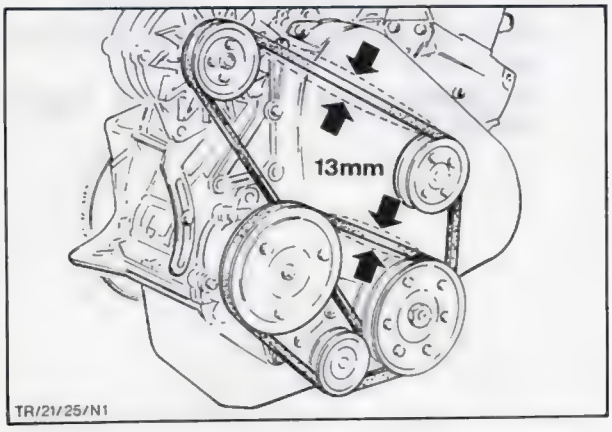


Fig. 154. Adjust alternator and vacuum pump V-belt tension

33. Insert radiator grille panel, complete with radiator, and secure, fit both headlamp surrounds.
34. Hook hood cable into catch, Fig. 155, and fit to radiator grille panel.

Fig. 155. Fit hood cable

35. Fit radiator at bottom location to crossmember mountings, Fig. 156.
36. Fit radiator hose and by-pass hose to expansion tank and fit upper and lower radiator hoses and tighten.
37. Top up coolant and check engine oil level.
38. Connect earth straps to both batteries, start engine and check for leaks.

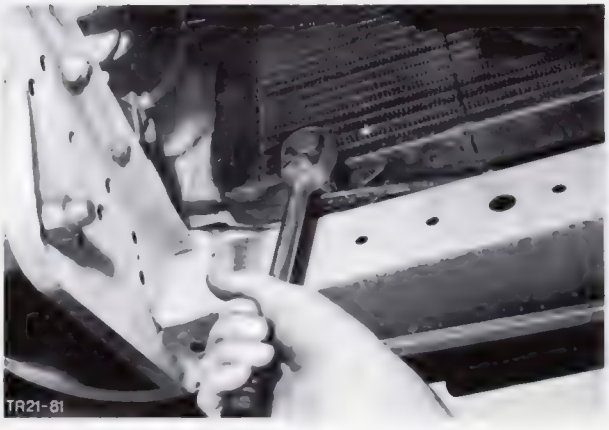


Fig. 156. Fit radiator at bottom location

21 468 4 OIL SEAL – CRANKSHAFT – REAR – REPLACE (engine or gearbox removed)

Special Service Tools Required:

Crankshaft rear oil seal remover . . 21–010
Crankshaft rear oil seal installer . .21–011–A
Clutch disc locator 21–044

To Remove

1. Remove clutch pressure plate and clutch disc (6 bolts).
2. Remove flywheel (8 bolts).
3. Remove crankshaft oil seal using Special Tool 21–010, Fig. 157.

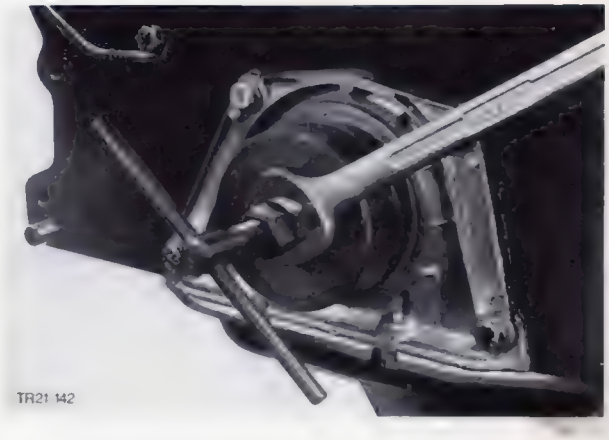


Fig. 157. Remove crankshaft oil seal using Special Tool 21–010

To Install

4. Lubricate crankshaft oil sealing lip and drive in up to stop, using Special Tool 21–011–A, Fig. 158.

Fig. 158. Drive in oil seal with Special Tool 21–011–A

5. Fit flywheel and secure as specified in Technical Data.

   Flywheel bolt holes are offset and flywheel may therefore be installed in one position only.

6. Centralise clutch pressure plate and clutch disc using Special Tool 21–044, Fig. 159 and torque as specified in Technical Data.

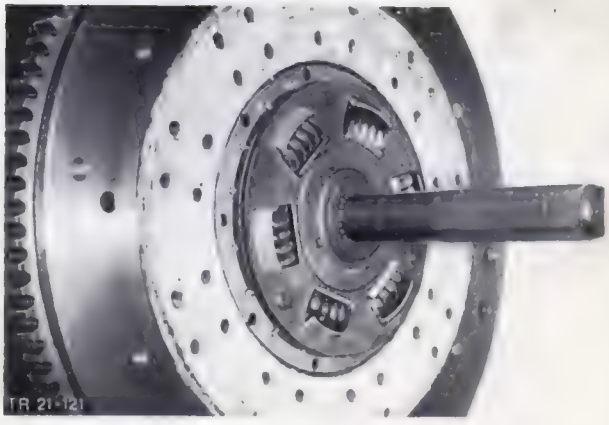


Fig. 159. Centralise clutch disc using Special Tool 21–044

21 505 5 PISTON – REPLACE (piston and connecting rod assembly removed)

Special Service Tools Required: None

To Remove

1. Remove circlips, Fig. 160 from piston pin bore.
2. Tap piston pin out of piston using a suitable hammer and drift.

Fig. 160. Remove circlips

Fig. 161. Heat piston on heater plate

To Install

3. Heat piston on hot plate, Fig. 161, apply oil to small end bore and slide piston pin into piston by hand until pin becomes located, then insert piston pin centrally into piston.

   Front mark on piston and connecting rod must be on same side, Fig. 162.

4. Fit circlips into piston pin bores.

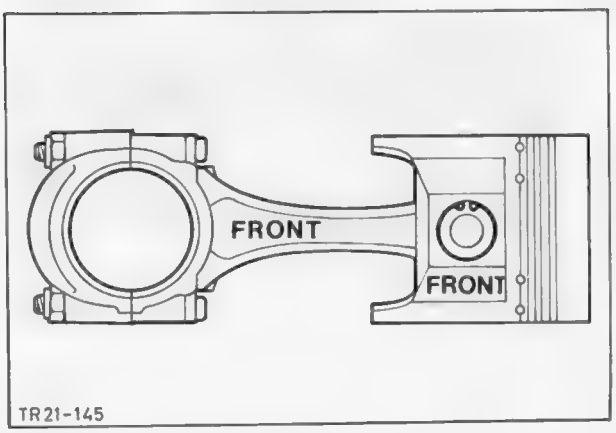


Fig. 162. Piston and connecting rod 'FRONT' mark

21 584 5 RING GEAR – FLYWHEEL – REPLACE (flywheel removed)

Special Service Tools Required: None

To Remove:

1. Centre punch ring gear and drill two holes approximately 7 or 8 mm (0,3 in) diameter offset as illustrated, Fig. 163.

   Drill must only pass through ring gear and not flywheel.

Fig. 163. Drill ring gear

2. Remove ring gear from flywheel by tapping with hammer, Fig. 164.
3. Place new ring gear on a plate some 2 to 3 mm (0,08 to 0,12 in) thick and heat up plate to 260° to 280 °C (500° to 540 °F) from below, in area of ring gear itself, using a welding torch to give uniform heating, Fig. 165. To monitor temperature, mark ring gear with a thermochromatic coloured pencil (Faber Castell 2815) before starting heating operation. On reaching temperature indicated on cover, colour marked on ring gear changes to colour on pencil cover.

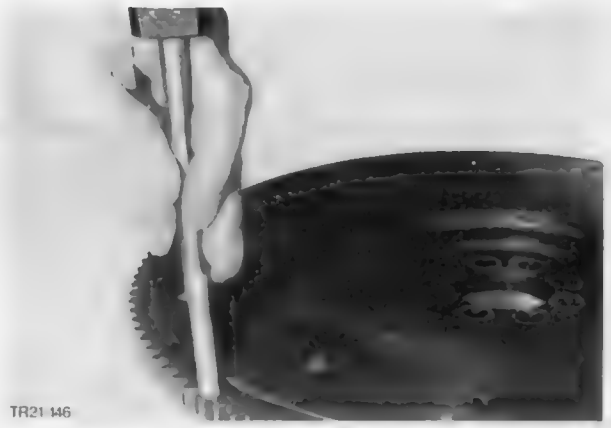


Fig. 164. Remove ring from flywheel

Example

If coloured pencil is green and cover black, indicated temperature (260° to 280 °C (500° to 540 °F)) is reached when green coloured mark on ring gear goes black.

To Install

4. Slip ring gear over flywheel with tongs so that ring gear comes to rest on abutment rim. Allow to cool in this position.

   Starter ring gear is induction-hardened and loses this hardness as soon as it is heated to over 290 °C (550 °F).

Fig. 165. Heat ring gear

21 714 OIL PUMP – REMOVE AND INSTALL

Special Service Tools Required:

Camshaft gear timing peg	21–016
Crankshaft flange holding wrench	21–018
Crankshaft flange bolt remover/replacer	21–019
Crankshaft front oil seal aligner	21–025

With the exception of removal and installation, as well as checking oil pump gear backlash this operation is contained in Operation **21 467 – Crankshaft front oil seal – replace** and should be carried out as follows:

To Remove

1. Carry out sub-operations 1–19 as described in Operation 21 467.
2. Remove oil pump complete with mounting from engine block (3 bolts), Fig. 166.

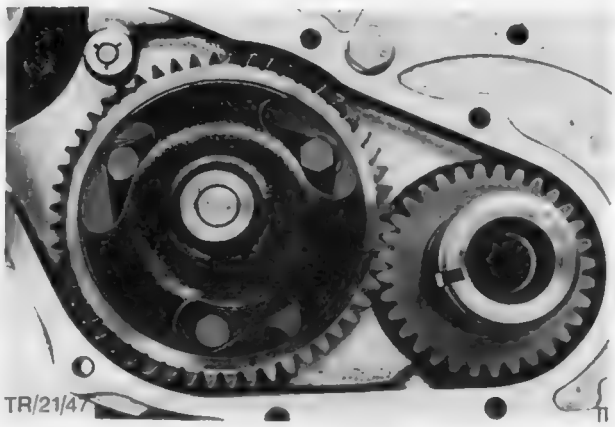


Fig. 166. Remove oil pump

To Install

3. Fit oil pump with new O-rings, Fig. 167 to mounting.

   Before installation crank oil pump by hand and fill with engine oil.

   Oil pump bores are offset and the pump may therefore be installed in one position only.

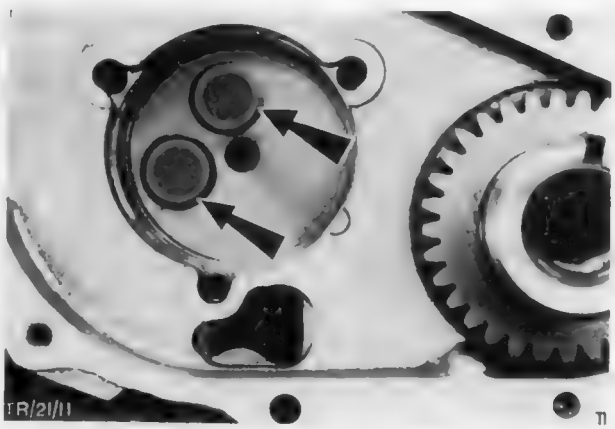


Fig. 167. Fit O-rings

4. Check oil pump gear backlash, Fig. 168 (see Technical Data) and fit new gears if required.
5. Carry out sub-operations 22–38 as described in Operation 21 467.

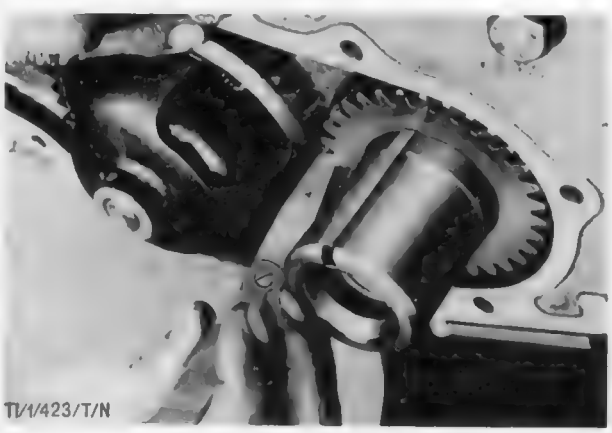


Fig. 168. Check backlash

21 714 8 OIL PUMP – OVERHAUL (oil pump removed)

Special Service Tools Required: None

To Dismantle

1. Remove oil pump cover (1 bolt).
2. Remove outer rotor by inverting pump.
3. Drive retaining pin out of gear and inner rotor and press out rotor, pump housing and retainer plate by means of suitable press.

To Reassemble

4. Assemble pump housing, retainer plate and inner rotor, sliding retainer plate recess behind housing lug, Fig. 169 and press gear on to shaft.

   If existing shaft is to be re-used drill retaining pin bore at 90° to the existing bore.

5. Drill **new** hole in rotor shaft. Secure rotor and gear with retaining pin.
6. Insert outer rotor with chamfered side into housing, Fig. 170.

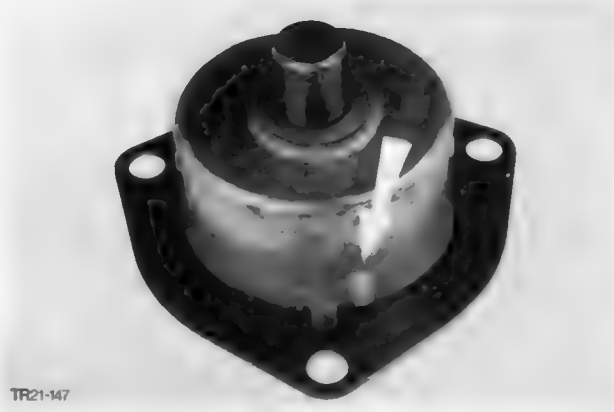


Fig. 169. Slide oil pump retainer plate behind pump housing lug

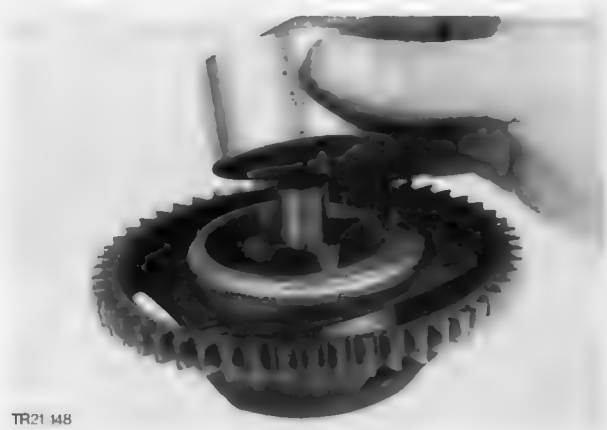


Fig. 170. Insert outer rotor with chamfered side into housing

7. Fit pump housing cover, ensuring bolt simultaneously engages in retainer plate recess, Fig. 171.

Fig. 171. Fit pump housing cover

21 714 8 (cont'd)

Check Oil Pump Wear:

(a) Clearance between inner and outer rotor, Fig. 172.

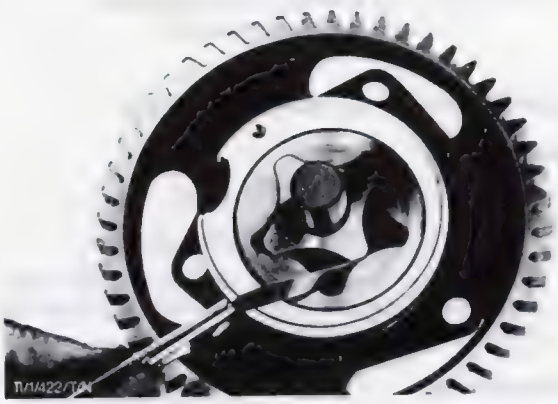


Fig. 172. Measure inner/outer rotor clearance

(b) Clearance between pump housing and outer rotor, Fig. 173.

Fig. 173. Measure clearance pump housing/outer rotor

(c) Clearance between rotors and pump housing joint face, Fig. 174.

Fig. 174. Check axial play

21 875 ENGINE FRONT MOUNTING RUBBER INSULATOR – REPLACE

Special Service Tools Required: None

To Remove

1. Remove upper and lower engine mounting rubber insulator nuts, Fig. 175.
2. Raise engine with jack and suitable wooden block from underneath sump far enough to enable rubber insulator complete with plate and washer to be removed.

Fig. 175. Remove nuts from engine mounting rubber insulator

To Install

3. Fit rubber insulator with plate and washer, Fig. 176 and lower engine
4. Secure upper and lower nut as specified in Technical Data.

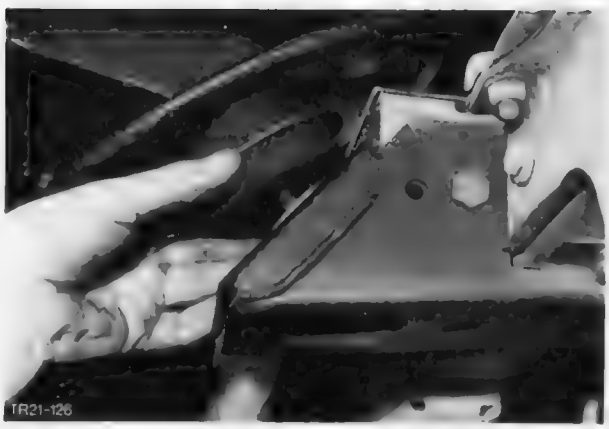


Fig. 176. Fit rubber insulator

TECHNICAL DATA — 'G'-ENGINE (OHV/1–4)

Engine

Engine code			4AA
Firing order			1–2–4–3
Bore		mm (in)	93,67 (3,69)
Stroke		mm (in)	85,60 (3,37)
Cubic capacity		cm^3	2358
Compression ratio			21,5:1
Compression pressure	bar (kgf/cm^2) (lbf/in^2)		28,0 (28,0) (406)
Cylinder pressure deviation approx.	bar (kgf/cm^2) (lbf/in^2)		8,0 (8,0) (116)
Output at 3600 rev/min	kw (hp)		46 (62)
Torque at 2750 rev/min	Nm (kgf m) (lbf ft)		130 (13,3) (96)
Idling speed rev/min			750

Cylinder Block

Number of main bearings			5
Cylinder bore dia. (measured 90 mm below top face)			
	grade 1	mm	93,648–93,680
	grade 2	mm	93,660–93,672
	grade 3	mm	93,672–93,684
	grade 4	mm	93,684–93,696
Main bearing bore	rear	mm	81,00–81,02
	remainder	mm	74,00–74,02
Camshaft bearing bore		mm	61,000–61,046

Crankshaft

Main bearing crank pin dia.	rear	mm	76,98–77,00
	remainder	mm	69,98–70,00
Main bearing shell length	front	mm	27,95–28,45
	intermediate	mm	34,04–34,30
	centre	mm	35,55–35,60
	rear	mm	30,10–30,85
Main bearing shell thickness	standard red	mm	1,970–1,979
	blue	mm	1,980–1,989
	undersize	mm	0,25/0,50/0,75
	oversize	mm	0,40
Main bearing clearance		mm	0,052–0,090
Main bearing shell width	front and intermediate	mm	22,87–23,13
	centre	mm	26,86–27,10
	rear	mm	21,87–22,13
Thrust washer thickness	standard	mm	2,31–2,36
	oversize	mm	0,06/0,12/0,18
		mm	0,25/0,40/0,50
Crankshaft end float		mm	0,05–0,25
Permissible wear		mm	0,33
Max. crankshaft cranking torque (without pistons)	Nm (kgf m) (lbf ft)		3 (0,3) (2,2)
Crankpin dia.		mm	59,98–60,00
Crankpin length		mm	32,28–32,38
Crankpin clearance		mm	0,036–0,088
Crankpin shell thickness	standard	mm	1,726–1,735
	undersize	mm	0,25/0,50/0,75/1,0
Crankpin shell width		mm	25,87–26,13
Number teeth crankshaft gear			32

Flywheel

Permissible run-out (at 120 mm radius) (T.I.R.)	mm (in)	0,16 (0,006 in)
Number of teeth on ring gear		108
Flywheel bolts		M 10x1
Flywheel ring gear fitting method (Interference shrink fit)	mm	0,30–0,53

TECHNICAL DATA (cont'd)

Cylinder Head

Valve guide length	standard inlet and exhaust	mm	61,50
Valve guide inside dia.	production	mm	8,982–9,013
	service	mm	8,988–9,008
Valve guide outside dia.	standard	mm	14,725–14,738
Valve seat insert recess dia.	standard inlet	mm	45,71–45,75
	exhaust	mm	37,96–38,00
Valve seat insert recess depth	inlet	mm	9,02–9,31
	exhaust	mm	9,02–9,31
Valve seat inserts – oversize	inlet outside dia.	mm	0,25 and 0,5
	exhaust outside dia.	mm	0,25 and 0,5
Valve seat angle	inlet	from	45° to 45°30′
	exhaust	from	30° to 30°30′
Valve head depth cylinder head	inlet	mm	0,66–1,18
	exhaust	mm	0,40–0,92

Tappets/Push Rods

Push rod length		mm	154,4–155,4
Push rod dia.		mm	7,72–8,03
Tappet dia.		mm	15,973–15,984
Tappet length		mm	62,00

Rocker Shaft/Rocker Arms

Rocker shaft dia.		mm	18,87–18,90
Number rocker arm springs			4
Spring length	at 1,8–2,3 kgf (4–5 lbf)	mm	26,92
Rocker arm bearing clearance		mm	0,02–0,08

Valves

Head dia.	inlet	mm	44,20–44,40
	exhaust	mm	36,20–36,40
Valve head seat angle	inlet		44°30′ to 45°
	exhaust		29°30′ to 30°
Valve stem clearance	inlet	mm	0,016–0,072
	exhaust	mm	0,034–0,090
Valve stem dia.	inlet	mm	8,941–8,966
	exhaust	mm	8,923–8,948

Valve Springs

Number of coils	exhaust outside		6,5
	exhaust inside		7,5
	inlet		6,2
Valve spring free length	exhaust outside	mm	51,4
	exhaust inside	mm	47,1
	inlet	mm	44,45
Spring pressure – valve open	exhaust outside	kgf (lbf)	59,7–64,3 (132–142)
	exhaust inside	kgf (lbf)	35,1–37,9 (77–83)
	inlet	kgf (lbf)	103,5 (338)

Valve Timing/Clearance

Valve timing at 0,534 mm (0,021 in) clearance	inlet valve opens		10 degrees B.T.D.C.
	closes		30 degress A.B.D.C.
	exhaust valve opens		54 degrees B.B.D.C.
	closes		10 degrees A.T.D.C.
Valve lift	inlet	mm	9,75
	exhaust	mm	10,50
Valve clearance cold, inlet and exhaust valve		mm	0,35 (0,014)

Camshaft

Number of bearings			5
Drive			via toothed belt
Cam lift	inlet	mm	6,5
	exhaust	mm	7,0
Bearing – oversize – outside dia.		mm	0,508
Journal dia.		mm	55,942–55,960
Camshaft bearing clearance		mm	0,075–0,114
Camshaft end float		mm	0,05–0,20

Pistons

Ring groove width	compression ring	upper	mm	2,258–2,278
		lower	mm	2,426–2,451
	oil scraper ring		mm	4,776–4,800
Piston pin bore		red	mm	28,9925–28,9950
		yellow	mm	28,9950–28,9975
		blue	mm	28,9975–29,0000
Piston clearance in bore			mm	0,128–0,152
Piston dia.		grade 1	mm	93,508–93,520
		grade 2	mm	93,520–93,532
		grade 3	mm	93,532–93,544
		grade 4	mm	93,544–93,556
Piston oversize			mm	0,65/1,00
Clearance between piston crown and block face at TDC			mm	0,114–0,213

Piston Ring

Compression ring		upper		chrome plated, barrel faced
		lower		chrome plated, stepped
Oil scraper ring				chrome plated, expansion spring
Ring gap	compression ring,	upper	mm	0,25–0,50
		lower	mm	0,25–0,50
	oil scraper ring		mm	0,25–0,581
Ring width	compression ring,	upper	mm	2,158–2,178
		lower	mm	2,350–2,375
	oil scraper ring		mm	4,724–4,737
Ring to groove clearance	compression rings		mm	0,041–0,089
	oil scraper ring		mm	0,039–0,076

Piston Pin

Type			floating in piston and connecting rod
Outside dia.		mm	28,990–28,998
Clearance in piston at 20 °C (68 °F)		mm	0,000–0,005
Retention method			circlips

Connecting Rods

Length		mm	153,975–154,025
Small end bore with bush		mm	29,010–29,022
Clearance between small end bush and piston pin		mm	0,0125–0,032
Big end bore		mm	63,506–63,520
Big end journal clearance		mm	0,036–0,088
Big end journal end float		mm	0,127–0,279

TECHNICAL DATA (cont'd)

Engine Lubrication

System		pressure feed
Oil grade		HD multi-purpose oil
Oil specification		ESEE-M2C-1004A or SP-M2C-9104A
	Viscosity below +10 °C (50 °F)	5W/20
	−20° to +10 °C (−4° to 50 °F)	5W/30
	−10° to +32 °C (14° to 90 °F)	10W/30
	−10° to +40 °C (14° to 104 °F)	10W/40
		10W/50
		20W/40
	above +20 °C (68 °F)	20W/50
Oil change	interval km (miles)	5000 (3000)
Oil capacity	without filter litre (pints)	5,2 (9,2)
	with filter litre (pints)	6,2 (10,9)

Oil Pump

Type			twin rotor
Drive gear backlash		mm	0,051–0,338
Capacity	at 2460 rev/min	litres/min	56
Pump housing bore dia.		mm	57,2262–57,3024
Drive shaft dia.		mm	15,8242–15,8369
Rotor end float		mm	0,017–0,098
Inner to outer rotor clearance	max.	mm	0,152
Outer rotor to housing clearance		mm	0,1362–0,3132

Tightening Torques

		Nm	kgf m	lbf ft
Main bearing bolts	1)	120–130	12,0–13,0	90
	2)	130–140	13,0–14,0	96
Connecting rod bolts	1)	48–62	4,8–6,2	40
	2)	62–73	6,2–7,3	50
Cylinder head (see tightening sequence)		142–152	14,2–15,2	105
Flywheel		60–65	6,0–6,5	45
Camshaft pulley		105–120	10,5–12,0	85
Oil drain plug		21–28	2,1–2,8	17
Rocker shaft	bolts M10	66–70	6,6–7,0	50
	M8	16–20	1,6–2,0	14
Cylinder block intermediate plate	bolts 1–9	27–33	2,7–3,3	21
	bolts 10	20–25	2,0–2,5	11
Oil pump cover intermediate plate		20–25	2,0–2,5	11
Oil sump		17–20	1,7–2,0	12
Inlet manifold		12–15	1,2–1,5	9
Exhaust manifold		41–51	4,1–5,1	33
Crankshaft centre bolt		318–346	31,8–34,6	240
Cylinder block rear oil seal carrier		18–21	1,8–2,1	14
Oil pump/cylinder block		17–20	1,7–2,0	14
Intermediate plate injection pump		22–30	2,2–3,0	17
Intermediate plate water pump		11–15	1,1–1,5	9
Camshaft/cylinder block blanking plate		13–18	1,3–1,8	11
Camshaft/cylinder block thrust plate		25–30	2,5–3,0	20
Vacuum pump intermediate plate		32–40	3,2–4,0	26
or blanking cover in lieu of vacuum pump		25–30	2,5–3,0	20
Oil filter – cylinder block (full flow filter)		21–25	2,1–2,5	17
Oil pump suction pipe		12–15	1,2–1,5	9
Oil pressure relief valve bolt		55–60	5,5–6,0	41
Toothed belt cover		5–9	0,5–0,9	5
Alternator bracket		20–29	2,0–2,9	17
Alternator to bracket		20–29	2,0–2,9	17